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Operations and Maintenance Manual for Expanded Bioventing Systems Facilities 44625D and 44625E

Cape Canaveral Air Station
Florida

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

45 CES/CEV
Patrick Air Force Base
Florida

May 1997

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PARSONS ENGINEERING SCIENCE, INC.
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May 30, 1997

Major Ed Marchand
AFCEE/ERT
3207 North Road, Bldg. 532
Brooks AFB, Texas 78235-5363

Subject: Operation and Maintenance Manual, Record Drawings, and Summary of Initial Results for the Expanded Bioventing System Installed at Facilities 44625D and 44625E; Horizontal Vent Well Installation at Facility 1748, Cape Canaveral AS, Florida (Contract F41624-92-8036, Delivery Order 17)

Dear Major Marchand:

This letter transmits three copies of the Operation and Maintenance (O&M) Manual prepared for the expanded bioventing system recently installed at Facilities 44625D and 44625E, Cape Canaveral Air Station (AS), Florida. Appendix A of the O&M Manual contains record drawings for the installed system. This letter also provides a summary of the work performed by Parsons Engineering Science, Inc. (Parsons ES) at Facilities 44625D and 44625E from November 1996 through March 1997, and at Facility 1748 in November 1996, and presents initial bioventing system operating parameters and sampling results. Copies of this letter and the O&M Manual also have been sent to Mr. Ed Worth at Patrick Air Force Base (AFB). Mr. Worth is the current point of contact for extended bioventing activities at Cape Canaveral AS as well as Patrick AFB.

FACILITIES 44625D AND 44625E

Summary of Field Activities

In December 1993, Parsons ES (formerly Engineering Science Inc. [ES], 1994) installed two bioventing pilot test systems at Facilities 44625D and 44625E to remediate soils impacted by waste oil from a former leaking underground storage tank (UST) and by numerous surface spills of petroleum products in the past (CH2M Hill, 1994). The pilot test systems installed at each site were composed of a single vertical vent well (VW) and several soil gas monitoring points (MPs). Three multi-depth MPs were originally installed at each of the Facility 44625 sites (CA3-MPA through C and CA4-MPA through C) and a fourth MP (CA4-MPD) was installed at Facility 44625E in December 1994 following startup of the systems in October 1994.

Based on positive results from the 1-year bioventing pilot tests, funding was provided by the Air Force Center for Environmental Excellence (AFCEE) to design and expand bioventing treatment of vadose zone soils at Facilities 44625D and 44625E.

An expanded bioventing system, consisting of three horizontal air injection vent wells HVWs; four new MPs, a blower system, and associated piping, controls, and electrical service, was installed at Facilities 44625D and 44625E. The seven existing MPs installed during previous pilot testing efforts (ES, 1994) will continue to be used to monitor system performance. Two regenerative blower systems that had been used for pilot-scale testing were removed from the site. System installation was performed by Parsons ES and subcontractors during two mobilizations. The first mobilization occurred between November 4 and 14, 1996, for installation of the majority of the system at Facilities 44625 D and 44625E and for the installation of an HVW at Facility 1748. The second mobilization occurred on March 4 and 5, 1997, during which a third air injection HVW was installed at Facilities 44625D and 44625E. The system at Facilities 44625D and 44625E was installed as described in the *Initial Remedial Action Plan for an Expanded Bioventing System, Facilities 44625D and 44625E, Cape Canaveral Air Station* (Parsons ES, 1996a). The only significant deviation from the work plan was the installation of one additional HVW (HVW3). HVW3 was installed after 3 months of system monitoring indicated that the initial two HVWs (HVWD and HVWE) were not sufficiently aerating the entire volume of contaminated soil designated for remediation. Figure 1 (attached) shows the site layout with the locations of the bioventing system components. Additional record drawings showing the final design details of the system components are provided in the enclosed O&M Manual.

Summary of Initial Sampling Results

Four soil and five soil gas samples were collected by Parsons ES for laboratory analysis during expanded system installation and prior to system startup. The soil samples were analyzed by Intertek Testing Services (formerly Inchcape Testing Services) of Richardson, Texas for benzene, toluene, ethylbenzene, and xylenes (BTEX) by US Environmental Protection Agency (USEPA) Method SW8020; total petroleum hydrocarbons (TPH) by Method SW8015 modified for diesel-range organics; and polynuclear aromatic hydrocarbons (PAHs) by USEPA Method SW8310. The soil gas samples were analyzed by Air Toxics, Ltd. of Folsom, California for BTEX and total volatile hydrocarbons (TVH) by USEPA Method TO-3. Prior to the collection of laboratory soil gas samples, soil gas samples from all existing and newly installed MPs were analyzed in the field by Parsons ES for oxygen, carbon dioxide, and TVH using direct-reading instruments. The results of the field screening were used to select the samples submitted for laboratory analysis. Soil and soil gas results are summarized in Tables 1 and 2 (attached), respectively, and sampling locations are shown on Figure 1.

Generally, petroleum hydrocarbon contamination at the site is concentrated beneath the concrete pads. Beyond the pads, soil contamination is generally confined to the smear zone, extending from a depth of approximately 3 feet below ground surface (bgs) to the groundwater surface, which was observed at depths ranging from approximately 4.5 to 5 feet bgs in November 1996, and from 5.5 to 6 feet bgs in March 1997.

Based on previous soil sampling conducted by Parsons ES during installation of the pilot-scale bioventing systems (ES, 1994), soil TPH concentrations are highest (exceeding 15,000 milligrams per kilogram [mg/kg]) along the northern edge of

Facility 44625E (CA4-MPA through D) and along the below-ground drain line (CA3-MPB). Contamination is assumed to extend beneath Facility 44625E. Much lower concentrations of TPH (between 12 and 423 mg/kg) detected in soil samples collected from MPE through MPH during expanded system installation (Table 1) confirm previous soil gas survey results (Parsons ES, 1996a) and indicate that soil hydrocarbon contamination has not migrated far from the source areas. Low oxygen and high TVH concentrations were measured in soil gas samples collected in November 1996 from the original pilot-scale MPs (CA3-MPA through C, and CA4-MPA through D) and from newly installed MPE and MPF (Table 2).

Initial Operation Parameters

The expanded bioventing system with two HVWs (HVWD and HVWE) was started on November 9, 1996. The air injection rate for each HVW was adjusted over a period of 5 days to allow the system to reach equilibrium and assure optimum air distribution to the contaminated soils. At the end of the initial optimization period (November 14, 1996), air was being injected into HVWD at a rate of approximately 11 cubic feet per minute (cfm) at a pressure of 4 inches of water, and into HVWE at a rate of approximately 58 cfm at a pressure of 29 inches of water. During this time, pressure response measured at the MPs ranged from a maximum of 1.2 inches of water at MPG at a depth of 3 feet bgs, to a minimum of 0.01 inch of water at CA3-MPA at a depths of 3 and 5.5 feet bgs. A pressure response of 0.03 inch of water was measured at MPE, the MP farthest from either HVW (75 feet from HVWE). Based on pressure response measurements, it appeared that the entire area of contaminated soil designated for bioventing treatment was being influenced by the expanded system. However, subsequent soil gas oxygen measurements indicated that along the northern edge of Facility 44625E, the oxygen was being utilized by soil microbes at a faster rate than oxygen was being supplied by air injection.

Because of the depleted soil gas oxygen concentrations measured along the northern edge of Facility 44625E, a third HVW (HVW3) was installed along the east edge of Facility 44625E in March 1997. Air injection into HVW3 began on March 5, 1997. The air injection rate for each of the three HVWs was adjusted over a period of 2 days to allow the system to reach equilibrium and assure optimum air distribution to the contaminated soils. At the end of this optimization period (March 7, 1997), air was being injected into HVWD at a rate of approximately 9 cfm at a pressure of 3.3 inches of water, into HVWE at a rate of approximately 42 cfm at a pressure of 17.5 inches of water, and into HVW3 at a rate of approximately 22 cfm at a pressure of 14 inches of water. On March 7, 1997, pressure response measured at the MPs ranged from a maximum of 1.4 inches of water at CA4-MPA at a depth of 5.5 feet, to a minimum of 0.01 inch at CA3-MPC at depths of 3 and 5.5 feet bgs. Based on pressure response, the entire area of contaminated soil designated for bioventing treatment was being influenced by the expanded system. Pressure response measured at each MP is shown on Table 3.

Oxygen, carbon dioxide, and TVH soil gas concentrations also were measured at the MPs before and after system optimization to confirm that the entire soil volume

designated for remediation is being oxygenated (greater than 5 percent oxygen) by the expanded bioventing system. The area with depleted oxygen concentrations designated for remediation is shown on Figure 1. This area was designated for remediation based on soil gas sampling results from June 1996 at 29 locations (Parsons ES, 1996a). Soil gas oxygen concentrations measured in March and April 1997 exceeded 7 percent at all MPs located within the area designated for remediation. Oxygen concentrations measured at CA4-MPD (3- and 5.5-foot depths), located outside the area designated for remediation, were depleted as a result of oxygen-depleted soil gas moving outward from contaminated areas. Soil gas oxygen concentrations measured at these two CA4-MPD monitoring depths during the soil gas survey performed in June 1996 (Parsons ES, 1996a) exceeded 5 percent. Table 4 summarizes the soil gas oxygen concentrations measured after 1 month of full-scale system (three HVWs) operation.

Operation and Maintenance

These sites have been funded for 1 year of system monitoring services under Option 1 of the AFCEE-sponsored Extended Bioventing Project. Option 1 involves O&M support for 1 year and system monitoring at the end of the year. The O&M support period began following system start-up and will continue until November 1997. In December 1997, Parsons ES will return to the site to perform additional respiration testing and soil gas sampling. The results of these monitoring activities will be used to develop recommendations for further action at this site.

Potential Vapor Migration

Air monitoring results indicate that expanded system operation will not result in increased offsite hydrocarbon vapor migration. As shown on Table 4, soil gas TVH concentrations at the perimeter MPs (MPE through MPH) have not increased as a result of air injection at the HVWs.

FACILITY 1748

Summary of Field Activities

In December 1993, Parsons ES installed a pilot-scale bioventing system at Facility 1748 to remediate soils impacted by diesel fuel from a former leaking storage tank. One vertical vent well (CA2-VW) and four soil gas monitoring points (CA2-MPA, CA2-MPB, CA2-MPC, and MPBG) were installed at the site. Subsequent system monitoring results indicated that seasonally high water table conditions prevented adequate soil aeration with the vertical vent well because the water level was above the top of the screen. Groundwater depths at the site can range from 2.5 feet bgs in the "rainy season" to 6 feet bgs in the "dry season." Because of inadequate aeration, the vertical vent well (CA2-VW) was replaced with a horizontal vent well (CA2-HVW) by Parsons ES in November 1996 to ensure oxygenation of vadose zone soils year-round. Figure 2 (attached) shows the locations of the existing MPs and blower system, abandoned CA2-VW, and as-built horizontal vent well CA2-HVW. CA2-HVW was

connected to the existing blower system and buried air line, and CA2-VW was abandoned.

CA2-HVW was installed using the same materials and methods used for the installation of HVWs installed at Facilities 44625D and 44625E (Parsons ES, 1996a). CA2-HVW was installed in a trench at a depth of approximately 2.5 feet below the pavement surface. A 2-inch diameter, 0.03-inch slot size, polyvinyl chloride (PVC) well screen was installed within a filter pack consisting of 6-20 mesh silica sand. The remainder of the trench was backfilled with native soil that was then compacted. The asphalt pavement over the trench was replaced with hot-mix asphalt to match existing pavement.

Summary of Soil Gas Field Results

Following HVW installation, the system was restarted and optimized to assure complete aeration of the contaminated soils at the site. Prior to system startup, soil gas samples from the MPs were screened to establish baseline oxygen, carbon dioxide, and TVH concentrations. The blower system was then started and adjusted to inject air into CA2-HVW at a rate of 24 cfm. Soil gas screening following approximately 2 days of system operation indicate that the entire volume of soil targeted for bioventing treatment was being adequately aerated. Table 5 presents the pressure response and changes in soil gas oxygen, carbon dioxide, and TVH concentrations measured at the MPs.

Operation and Maintenance

Parsons ES is no longer responsible for maintenance of the bioventing system at Facility 1748. Option 1 testing at the site was completed in June 1996 and a letter (Parsons ES, 1996b) detailing extended system operation test results was provided to AFCEE and Mr. Hugh Houghton, the former site point of contact. Based on Option 1 testing results, a significant amount of residual fuel remains in soil at the site, and significant biodegradation of the petroleum-contaminated soil is still occurring. As a result, initiation of site closure activities (Option 2) which has been funded by AFCEE has been delayed, and will be exercised at a future date. Patrick AFB/Cape Canaveral AS personnel are now responsible for operation and maintenance of the bioventing system.

If you have any questions or comments regarding the information contained in this letter or in the enclosed O&M Manual, please contact me at (303) 831-8100 or Steve Archabal at (602) 852-9110.

Sincerely,

PARSONS ENGINEERING SCIENCE, INC.

John Ratz, P.E.
Project Manager

Attachments: References, Figure 1 and 2, Tables 1-5

Enclosure: O&M Manual

cc: Ed Worth (Patrick AFB)
Ron Bond (Patrick AFB)
Steve Archabal (Site Manager, Parsons ES-Phoenix)
John Hall (Site Engineer, Parsons ES-Grand Junction)
Bob Sorvillo (Parsons ES-Orlando)
Grant Watkins (Parsons ES-Raleigh-Durham)
File 726876.26110.B
File 726876.26243.L

References

CH2M Hill, Inc. 1994. *Contamination Assessment Report, Facility 44625 A/D, Cape Canaveral Air Station.* August.

Engineering-Science, Inc. 1994. *Draft Interim Pilot Test Results Report for Facilities 1748, 44625D, and 44625E, Cape Canaveral Air Force Station, Florida.* May.

Parsons Engineering Science, Inc. 1996a. *Initial Remedial Action Plan for an Expanded Bioventing System, Facilities 44625D and 44625E, Cape Canaveral Air Station, Florida.* October.

Parsons Engineering Science, Inc. 1996b. *Extended Bioventing Testing Results at Fire Training Area 2 (FTA-2), Patrick Air Force Base; and FTA-2 and Facility 1748, Cape Canaveral Air Station.* 12 July.

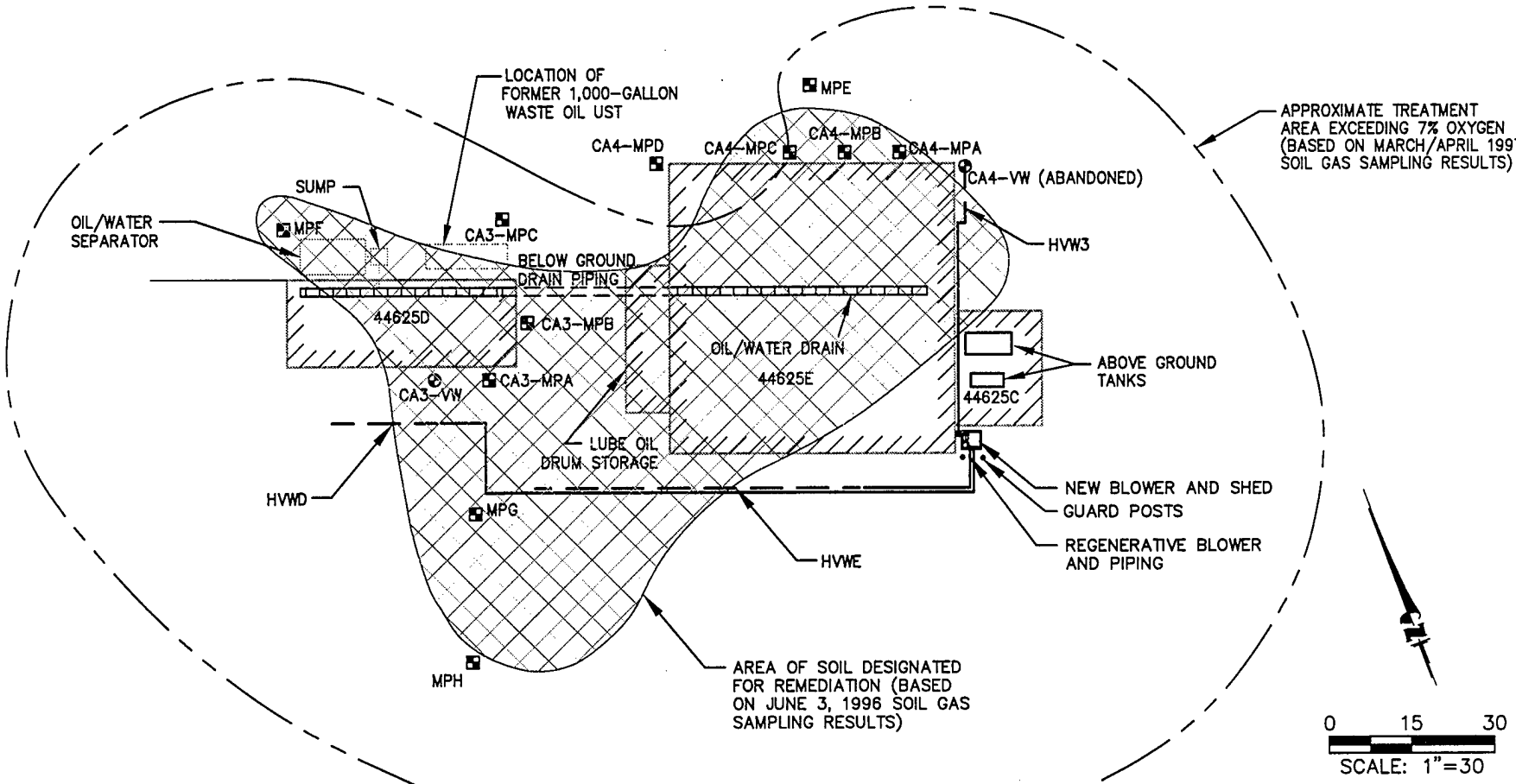

FIGURE 1

SITE LAYOUT AND EFFECTIVE TREATMENT AREA

Facilities 44625D and 44625E
Cape Canaveral AS, Florida

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Denver, Colorado

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TABLE 1
SOIL ANALYTICAL RESULTS[a/]

FACILITIES 44625D AND 44625E
CAPE CANAVERAL AS, FLORIDA

Analyte (Units)[b/]	Sample Location-Depth (feet below ground surface)			
Soil Hydrocarbons	MPE-4	MPF-4	MPG-4	MPH-4
TPH (mg/kg)	423	60.3	12.4	49.0
Benzene (µg/kg)	5.2 U[c/]	1.1 U	1.1 U	1.0 U
Toluene (µg/kg)	10.4 U	2.1 U	2.1 U	2.1 U
Ethylbenzene (µg/kg)	10.4 U	2.1 U	2.1 U	2.1 U
Xylenes (µg/kg)	82.9	2.1 U	2.1 U	2.1 U
Chrysene (µg/kg)	654	10.6 U	10.8 U	10.5 U
Dibenz(a,h)-anthracene (µg/kg)	372	21.3 U	21.6 U	21.0 U
Fluoranthene (µg/kg)	138	14.9 U	15.1 U	14.7 U
Pyrene (µg/kg)	448	23.8	19.4 U	18.9 U
Moisture (% wt.)	4.1	5.6	6.9	4.5

a/ Soil samples collected 7 November 1996.
b/ (mg/kg) = milligrams per kilogram. (µg/kg) = micrograms per kilogram. (% wt.) = percent by weight.
c/ U = compound analyzed for, but not detected. Number shown represents the method detection limit.
Note: Laboratory analysis performed for 16 polynuclear aromatic hydrocarbons by U.S. Environmental Protection Agency Method SW8310; only those analytes shown were detected in one or more soil samples.

TABLE 2
INITIAL FIELD SOIL GAS AND LABORATORY ANALYTICAL RESULTS[a/]

FACILITIES 44625D AND 44625E
CAPE CANAVERAL AS, FLORIDA

		Field Screening Data			Laboratory Analytical Data				
Sample Location	Screen Depth (feet)	Oxygen (%)	Carbon Dioxide (%)	TVH (ppmv)[b/]	Benzene (ppmv)	Toluene (ppmv)	Ethylbenzene (ppmv)	Xylenes (ppmv)	TVH (ppmv)
CA3-MPA	3	0.0	6.4	200	----[c/]	----	----	----	----
	5.5	0.0	7.0	200	----	----	----	----	----
CA3-MPB	3	0.0	8.0	320	0.002 U[d/]	0.003	0.005	0.002	2.3
	5.5	0.0	7.9	360	----	----	----	----	----
CA3-MPC	3	13.9	4.8	220	----	----	----	----	----
	5.5	0.0	14.2	340	----	----	----	----	----
CA4-MPA	3	0.0	15.0	8,000	0.011 U	0.011 U	0.011 U	0.047 M[e/]	2.0
	5.5	0.0	15.0	8,400	----	----	----	----	----
CA4-MPB	3	0.0	15.1	>20,000	0.011 U	0.011 U	0.011 U	0.046 M	26
	5.5	0.0	15.2	>20,000	----	----	----	----	----
CA4-MPC	3	0.0	15.0	>20,000	0.021 U	0.024	0.021 U	0.67 M	71
	5.5	0.0	15.1	>20,000	----	----	----	----	----
CA4-MPD	3	11.8	5.9	260	----	----	----	----	----
	5.5	----	----	----	----	----	----	----	----
MPE	3	0.0	14.0	7,000	0.021 U	0.026 M	0.021 U	0.19	66
MPF	3	11.6	4.5	300	----	----	----	----	----
MPG	3	18.0	0.9	80	----	----	----	----	----
MPH	3	18.5	1.3	120	----	----	----	----	----

a/ Soil gas samples collected 8 November 1996.

b/ TVH = total volatile hydrocarbon results reported in parts per million, volume per volume. Field screening results include methane.

c/ ---- = not analyzed.

d/ U = compound analyzed for, but not detected. Number shown represents the method detection limit.

e/ M = reported value may be biased due to apparent matrix interferences.

TABLE 3
MAXIMUM PRESSURE RESPONSE AT SYSTEM MONITORING POINTS

FACILITIES 44625D AND 44625E
CAPE CANAVERAL AS, FLORIDA

AIR INJECTION PRESSURES AND FLOW RATES

HVWD	8.9 cfm at a pressure of 3.3 in. H_2O
HVWE	42.2 cfm at a pressure of 17.5 in. H_2O
HVW3	22.2 cfm at a pressure of 14.0 in. H_2O

Location	Distance From Nearest HVW (feet)	Screen Depth (feet bgs) [a/]	Maximum Pressure Response[b/] (inches of water)
CA3-MPA	10	3.0	0.76
		5.5	0.78
CA3-MPB	25	3.0	0.40
		5.5	0.46
CA3-MPC	40	3.0	0.01
		5.5	0.01
CA4-MPA	71.5	3.0	1.30
		5.5	1.40
CA4-MPB	71.5	3.0	0.56
		5.5	0.59
CA4-MPC	71.5	3.0	0.32
		5.5	0.30
CA4-MPD	70	3.0	0.10
		5.5	0.11
MPE	75	4.0	0.22
MPF	35	4.0	0.04
MPG	16	4.0	0.82
MPH	30	4.0	0.46

[a/] bgs = below ground surface.
[b/] Measurements taken on 7 March 1997.

TABLE 4
AIR INJECTION INFLUENCE ON OXYGEN CONCENTRATIONS AT SYSTEM MONITORING POINTS

FACILITIES 44625D AND 44625E
CAPE CANAVERAL AS, FLORIDA

Location	Distance From Nearest HVW (feet)	Screen Depth (feet bgs) [a/]	Initial Oxygen [b/] (%)	Final Oxygen [c/] (%)	Initial TVH [b/] (ppmv)	Final TVH [c/] (ppmv)
CA3-MPA	10	3.0	0.0	21.0	200	60
		5.5	0.0	21.0	200	54
CA3-MPB	25	3.0	0.0	20.1	320	64
		5.5	0.0	20.9	360	64
CA3-MPC	40	3.0	13.9	16.0	220	200
		5.5	0.0	9.0	340	300
CA4-MPA	12	3.0	0.0	21.0	8,000	40
		5.5	0.0	21.0	8,400	64
CA4-MPB	20	3.0	0.0	18.0 [d/]	>20,000	200
		5.5	0.0	19.2 [d/]	>20,000	300
CA4-MPC	30	3.0	0.0	7.0 [d/]	>20,000	360
		5.5	0.0	9.5 [d/]	>20,000	640
CA4-MPD	52	3.0	11.8	2.5 [d/]	260	220
		5.5	Saturated [e/]	0.0 [d/]	Saturated	240
MPE	32	4.0	0.0	8.0	7,000	320
MPF	35	4.0	11.6	19.0	300	124
MPG	16	4.0	18.0	21.0	80	30
MPH	30	4.0	18.5	21.0	120	20

[a/] bgs = below ground surface.

[b/] Measurements taken on 8 November 1996 prior to air injection at HVWD, HVWE, and HVW3.

[c/] Measurements taken on 7 March 1997 except as noted.

[d/] Measurements taken on 8 April 1997.

[e/] Soil saturated at this interval. Unable to obtain soil gas sample.

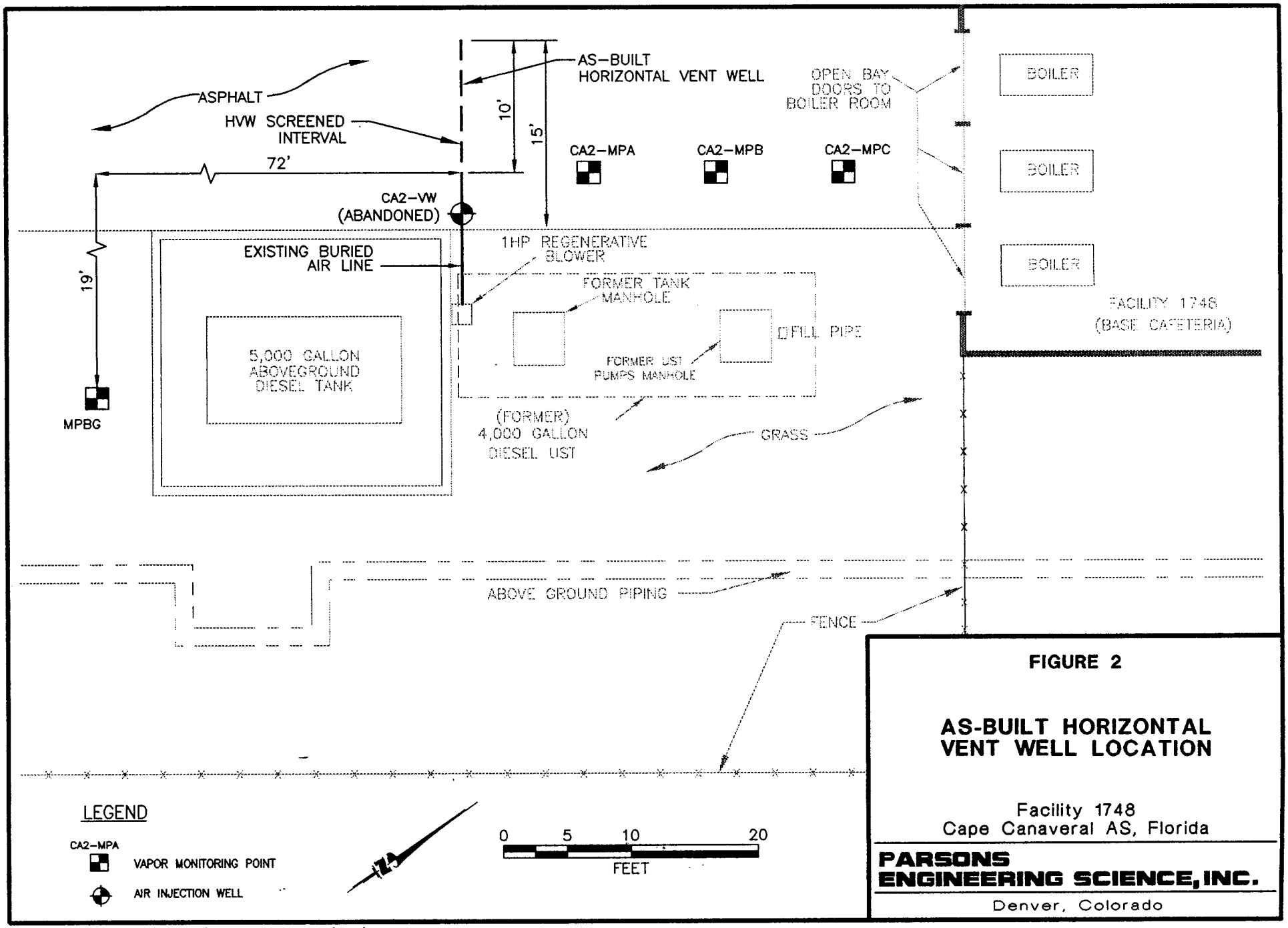

FIGURE 2

AS-BUILT HORIZONTAL VENT WELL LOCATION

Facility 1748
Cape Canaveral AS, Florida

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TABLE 5
PRESSURE RESPONSE AND INFLUENCE ON
SOIL GAS FIELD RESULTS
FACILITY 1748
CAPE CANAVERAL AS, FLORIDA

				Pre-Startup Measurements (11/11/96) [a]			Post-Optimization Measurements (11/13/96) [b]		
Location	Distance From HVW (feet)	Screen Depth (feet)	Pressure Response (in. H_20) [c]	Oxygen (%)	Carbon Dioxide (%)	TVH (ppmv) [d]	Oxygen (%)	Carbon Dioxide (%)	TVH (ppmv)
CA2-MPA	10	3.0	1.2	7.1	6.7	300	21.0	0.1	44
		5.5	1.1	1.0	11.6	440	20.2	0.7	200
CA2-MPB	20	3.0	0.6	3.3	9.0	320	20.7	0.5	36
		5.5	0.6	0.0	11.6	400	19.2	1.3	128
CA2-MPC	30	3.0	0.2	1.5	11.5	360	20.5	0.5	28
		5.5	0.2	0.0	13.0	660	16.6	3.5	156

[a] Measurements taken prior to re-starting system.
[b] Measurements taken after approximately 2 days of system operation.
[c] in. H_20 = inches of water.
[d] ppmv = parts per million, volume per volume. Meter adjusted for full-gas response.

CONTENTS

SECTION 1

INTRODUCTION

This Operations and Maintenance (O&M) Manual has been created as a guide for monitoring and maintaining the performance of the expanded bioventing blower system and vent well plumbing at Facilities 44625D and 44625E at Cape Canaveral Air Station (AS), Florida. Record drawings of the expanded bioventing system installed at Facilities 44625D and 44625E are provided in Appendix A.

Bioventing is the forced injection of fresh air, or withdrawal of soil gas, to enhance the supply of oxygen in subsurface soils for *in situ* bioremediation. A blower system is used to inject air into the soil, thereby supplying fresh atmospheric air (with approximately 20.8 percent oxygen) to contaminated soils. Once oxygen is provided to the subsurface, existing bacteria aerobically break down fuel residuals. Aerobic biodegradation is much more efficient than anaerobic biodegradation which occurs in oxygen depleted soils.

Parsons Engineering Science, Inc. (Parsons ES) has installed an air injection bioventing system consisting of one air injection blower, three horizontal vent wells (HVWs), eleven soil gas monitoring points (MPs), and associated piping at the site. Following the installation and testing of a pilot-scale bioventing system from October 1994 through December 1995, Parsons ES installed an expanded (full-scale) bioventing system including HVWD and HVWE and initiated system operation on November 9, 1996. When early monitoring results showed that the area north of Facility 44625D was not receiving a sufficient supply of oxygen, a third vent well (HVW3) was installed on March 5, 1997 to address the oxygen deficiency. The air injection rates of the full-scale bioventing system were optimized at each vent well to assure adequate aeration of contaminated soils to promote aerobic biodegradation. Soil gas monitoring performed in March and April 1997, after the installation of HVW3, indicates that the entire area designated for bioventing treatment is receiving an adequate supply of oxygen.

Cape Canaveral AS personnel are responsible for routine monitoring of the bioventing system. Parsons ES has trained AS personnel on the maintenance requirements of this plan. If significant problems are encountered with the operation of the system, Parsons ES should be notified so repairs can be made. Under the Extended Bioventing Project Option 1, Parsons ES is responsible for system repair for a 1-year period after system startup. Parsons ES will retain responsibility for system repair until November 1997. Should the bioventing system cease to operate or develop a significant problem, please call the Parsons ES Site Manager, Mr. Steve Archabal, at (602) 852-9110, or Mr. John Hall, at (970) 244-8829. If the system ceases to operate, please have a base electrician verify that adequate power is being supplied to the bioventing system blower motor prior to notifying Parsons ES.

SECTION 2

SYSTEM DESCRIPTION

2.1 BLOWER SYSTEM

A Gast® R5 blower powered by a 2-horsepower direct drive motor was installed at Facilities 44625D and 44625E on November 9, 1996. The R5 blower is rated as having a maximum flow rate of 160 standard cubic feet per minute (scfm) at open flow and a maximum pressure of 55 inches of water. As installed, the blower at Facilities 44625D and 44625E was producing an estimated flow rate of 73 actual cubic feet per minute (acfm) at a pressure of 30 inches of water. Following adjustment of HVW air injection rates, approximately 9 acfm is being injected into HVWD, 42 acfm into HVWE, and 22 acfm into HVW3. Flow was optimized to each HVW based on the degree of hydrocarbon contamination present within soils in the vicinity of each HVW and the amount of oxygen measured at system MPs following two months of operation. The blower system includes an inlet air filter to remove any particulates which are entrained in the inlet air stream and several valves and monitoring gauges which are described in Section 2.2. A schematic of the expanded blower system installed at Facilities 44625D and 44625E is shown in Appendix A. Corresponding blower performance curves and relevant service information are provided in Appendix B. Blower system data collection sheets for use by facility personnel are provided in Appendix C.

2.2 MONITORING AND FLOW CONTROL EQUIPMENT

2.2.1 Monitoring Gauges

The bioventing system is equipped with vacuum, pressure, and temperature gauges, and air velocity measurement ports. Gauges have been installed on the air injection system at the following locations: a vacuum gauge in the inlet piping and pressure and temperature gauges in the outlet piping.

2.2.2 Flow Control Equipment

Manual and automatic flow control valves (FCVs) have been installed on the bioventing blower system. Manual FCVs have been installed in the piping leading to each HVW to enable the flow rate to each HVW to be adjusted individually. An automatic FCV, or pressure relief valve (PRV), is used to protect the blower system from burning out if pressures rise due to pipe blockage. The PRV is set to bleed off flow at a preset pressure and thus prevent blower outlet pressure from ever exceeding the rated pressure.

An additional FCV (bleed valve) has been installed to control the total air flow out of the blower by releasing excess air flow to the atmosphere. The FCVs have been set by Parsons ES

personnel to deliver a calculated amount of air to each HVW and should not be adjusted unless directed to do so by Parsons ES personnel.

The blower system has also been equipped with flow measurement ports. These ports consist of brass bushings installed in the outlet piping leading to each HVW. These bushings, which should be plugged during system operation, allow the insertion of a thermal anemometer for the measurement of air velocity. These ports are used by Parsons ES for system optimization.

Although the blower system installed at Facilities 44625D and 44625E is relatively maintenance free, periodic system maintenance is required for proper operation and long life. Recommended maintenance procedures and schedule are described in detail in the instruction manuals included in Appendix B and briefly summarized in this section.

Filter inspection must be performed with the system turned off. Do not change the flow control valve settings (valves have been pre-set for a specific flow rate) before re-starting the blower.

SECTION 3

SYSTEM MAINTENANCE

3.1 BLOWER/MOTOR

The blower and motor are relatively maintenance free and should not require any maintenance during the operational period. Both the blower and motor have sealed bearings and do not require lubrication.

3.2 AIR FILTER

To avoid damage caused by passing solids through the blower, an air filter has been installed in-line before the blower. The paper filter element is accompanied by a polyurethane foam pre-filter. The filter should be checked weekly for the first 2 months of operation. A facility employee should determine the best schedule for filter replacement based on the first 2 months of system monitoring. The polyurethane pre-filters can be washed with lukewarm water and a mild detergent. Paper filter elements should never be washed, and should be disposed of and replaced as necessary. When the vacuum drop across the filter increases by approximately 5.5 inches of water from the vacuum when the filter was new, a dirty filter element should be suspected, and cleaning or replacement should be performed. The initial vacuum when the filter element was new was 9.5 inches of water. Therefore, the filter should be cleaned or replaced when the vacuum increases to 15 inches of water. Typical filter element replacement intervals range from 3 to 6 months.

To remove the filter, turn the system off by pushing the stop button on the starter, loosen the three clamps or the wing nut on the filter top, lift the metal top off the air filter, and lift the air filter element from the metal housing. Remove the polyurethane pre-filter (if applicable) and wash before replacing.

The filter element is manufactured by Solberg Manufacturing, Inc. in Itasca, Illinois. Their toll free telephone number is 1-800-451-0642. Additional filters can also be obtained through Parsons ES. The Parsons ES contacts are Mr. Steve Archabal, at (602) 852-9110, and Mr. John Hall, at (970) 244-8829. The part number for the replacement filter element is 30P. Four spare air filter elements have been placed inside the blower enclosure.

3.3 MAINTENANCE SCHEDULE

The following maintenance schedule is recommended for the blower system. During the initial few months of operation more frequent monitoring is recommended to ensure that any startup problems are quickly corrected. A daily drive-by inspection is recommended during the initial 2 weeks of operation to ensure that the blower system is still operating with no unusual sounds. Thereafter monitoring inspections every 2 weeks are recommended (see

Section 4). Preprinted data collection sheets have been provided to the facility. Extra data collection sheets for recording maintenance activities are provided in Appendix C.

Maintenance Item	Maintenance Frequency
Filter	Check once every 2 weeks, wash or replace as necessary (see Section 3.3). Inlet vacuum exceeding 15 inches of water indicates that the filter requires cleaning or replacement.

3.4 MAJOR REPAIRS

Blowers systems are very reliable when properly maintained. Occasionally, however, a motor or blower will develop a serious problem. If a blower system fails to start, and a qualified electrician verifies that power is available at the blower or starter, Parsons ES should be contacted to arrange for repairs. The Parsons ES contacts are Mr. Steve Archabal, at (602) 852-9110, and Mr. John Hall, at (970) 244-8829. Parsons ES is responsible for major repairs during the first year of operation.

SECTION 4

SYSTEM MONITORING

4.1 BLOWER PERFORMANCE MONITORING

To monitor the blower performance, the vacuum, pressure, and temperature will be measured. These data should be recorded every 2 weeks on a data collection sheet (provided in Appendix C). All measurements should be taken at the same time while the system is running. Because the systems are noisy, hearing protection should be worn at all times.

4.1.1 Vacuum/Pressure

With hearing protection in place, unlock and open the blower enclosure and record all vacuum and pressure readings directly from the gauges (in inches of water). Record the measurements on the data collection sheet.

4.1.2 Temperature

With hearing protection in place, open the blower enclosure and record the temperature readings directly from the gauges in degrees Fahrenheit (°F). Record the measurements on a data collection sheet (provided in Appendix C). The temperature change can be converted to degrees Celsius (°C) using the formula $°C = (°F - 32) \times 5/9$.

4.2 MONITORING SCHEDULE

The following monitoring schedule is recommended for these systems. During the initial month of operation, more frequent monitoring is recommended to ensure that any start up problems are quickly corrected. Data collection sheets have been provided to assist your data collection and are included in Appendix C.

Monitoring Item	Monitoring Frequency
Vacuum/Pressure	Once every 2 weeks.
Temperature	Once every 2 weeks.

4.3 REPORTING MONITORING RESULTS

System monitoring data sheets should be faxed to the Parsons ES Site Manager, Mr. Steve Archabal at (602) 852-9112, once every 2 months. However, if a significant change in the system temperature or pressure is noted (such as a significant drop or increase in pressure)

please call Mr. Archabal at (602) 852-9110 immediately. A significant change in system temperature or pressure may be indicative of a problem with the air delivery system or blower.

APPENDIX A

RECORD DRAWINGS

RECORD DRAWINGS FOR

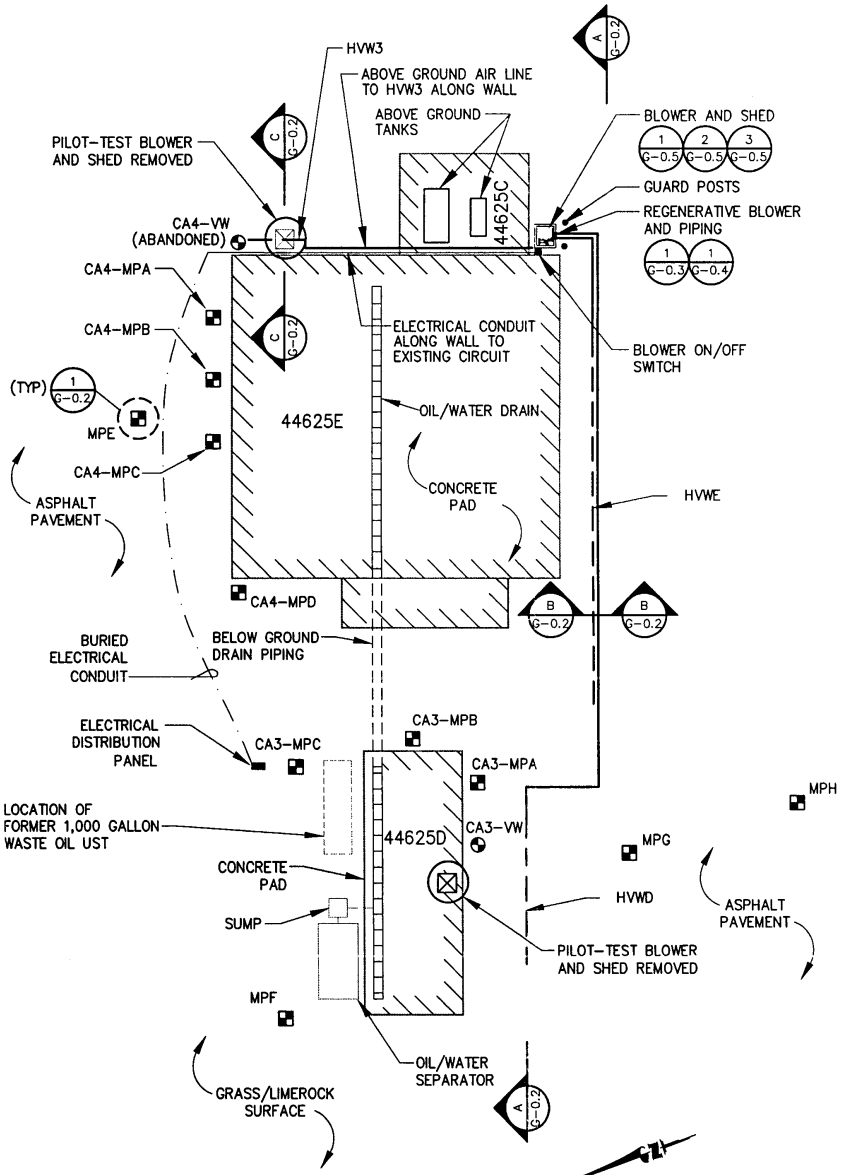
EXPANDED BIOVENTING SYSTEM FACILITIES 44625D AND 44625E CAPE CANAVERAL AIR STATION

PREPARED FOR

AFCEE

MARCH 1997

DRAWING INDEX



SITE LAYOUT

SCALE: 1" = 20'

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Designed	SA					
Drawn	MW					
Checked						
Reviewed						
Approved	CEE	5/7/97				
Reg No			A	RECORD DRAWINGS		
Date			Rev	Date	Description	By

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM FACILITIES 44625D AND E CAPE CANAVERAL AIR STATION

TITLE SHEET AND SITE LAYOUT

DRAWING NO G-0.1 | REV A

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ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
CBM	CENTER BACK MOUNT
CLR	CLEAR
DIA	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HVW	HORIZONTAL VENT WELL
ie	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIL	MILLIMETER
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST STL	STAINLESS STEEL
TYP	TYPICAL
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W/	WITH
WN	WELD NECK

MATERIAL LEGEND

- ASPHALT
- CEMENT-STABILIZED SOIL
- BENTONITE/CEMENT GROUT
- BENTONITE PELLETS
- BUILDING (EXISTING)
- COMPACTED BACKFILL
- COMPACTED BASE STONE
- CONCRETE
- PEA GRAVEL
- SAND
- UNDISTURBED SOIL

PIPE MATERIAL

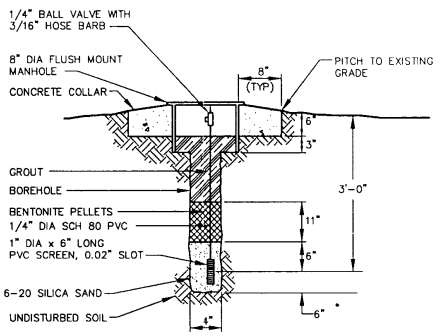
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

SYMBOLS

- BURIED HEADER PIPE
- HORIZONTAL VENT WELL SCREENED INTERVAL
- CA3-MPA — PERMANENT VAPOR MONITORING POINT
- CA3-VW — PILOT-SCALE VENT WELL (UNUSED)

SECTION DESIGNATION (A / X) — DRAWING OF ORIGIN; SECTION NAME: **SECTION CUT**; SCALE: NTS; SCALE

DETAIL NUMBER (1 / X) — DRAWING OF ORIGIN; DETAIL NAME: **DETAIL DESCRIPTION**; SCALE: NTS; SCALE



1 / – VAPOR MONITORING POINT CONSTRUCTION DETAIL
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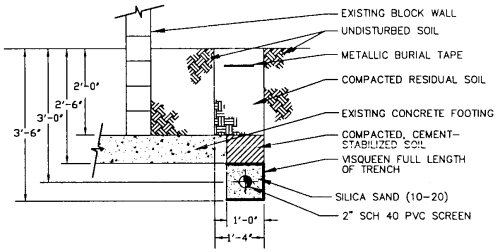

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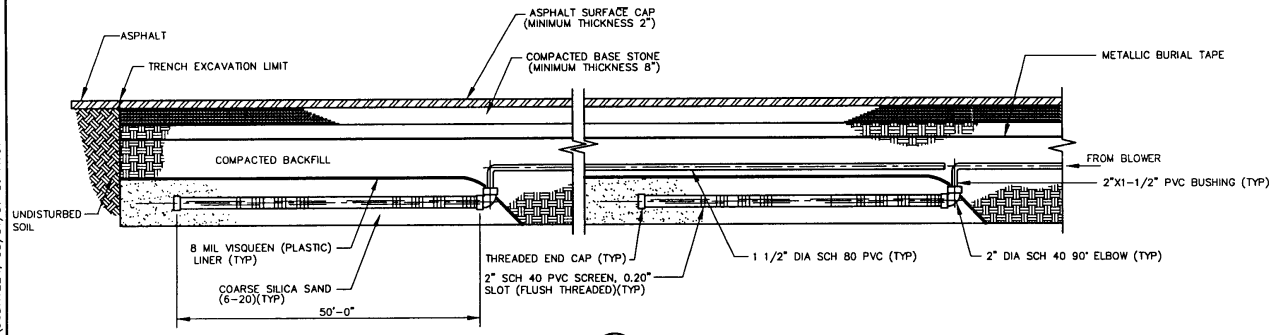

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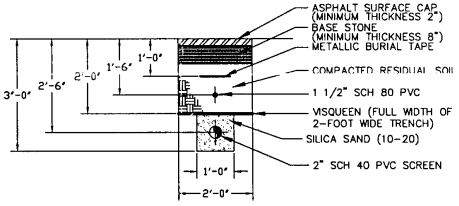

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Drawn	MW			
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Reviewed				
Approved		5/1/97	A	RECORD DRAWING
Reg No.			Rev	Description
Date				By

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Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM FACILITIES 446250 AND E
CAPE CANAVERAL AIR STATION

LEGEND, STANDARD TRENCH DETAILS, HORIZONTAL VENT WELL, AND MONITORING POINT STANDARD DETAILS

DRAWING NO G-0.2 | REV A

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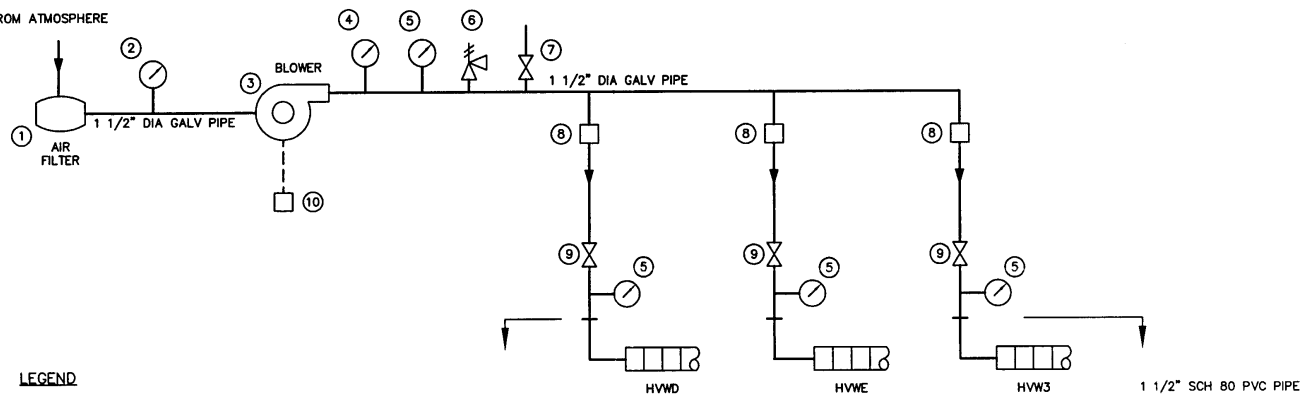

LEGEND

(1) INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P

(2) VACUUM GAUGE – GAST® AJ497, 2 5/8" DIA, 0–60" H $_2$O, 1/4" NPT, LM (Part No. AJ497)

(3) BLOWER – GAST® 2.0 HP R5125Q-50, 120 CFM AT 30" H_2O PRESSURE

(4) TEMPERATURE GAUGE – ASHCROFT, 0–250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)

(5) PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA, 0–100" H $_2$O, 1/4" NPT, CBM (Part No. 9851879)

(6) AUTOMATIC PRESSURE RELIEF VALVE – GAST AG258, SET TO RELEASE AT 55" H_2O PRESSURE

(7) MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE

(8) FLOW MEASURING PORT FITTED WITH PLUG (1/4"x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)

(9) FLOW CONTROL VALVE – 1 1/2" GATE

(10) ON/OFF SWITCH

1/– BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

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Drawn	MW				
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Reviewed					
Approved		5/16/97	A	RECORD DRAWING	
Reg No			Rev	Date	Description
Date					

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Denver, Colorado
(303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
FACILITIES 44625D AND E
CAPE CANAVERAL AIR STATION

BLOWER PIPING AND INSTRUMENTATION DIAGRAM

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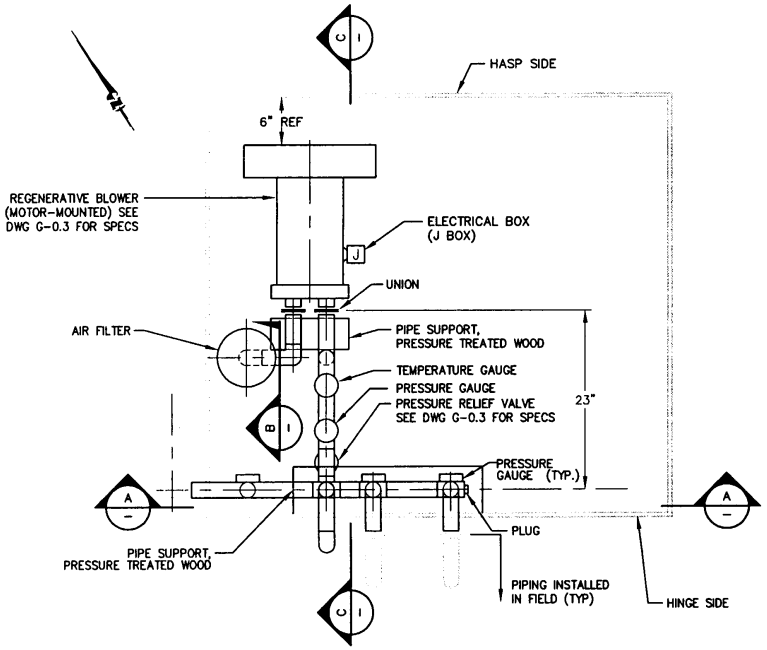
REV: A

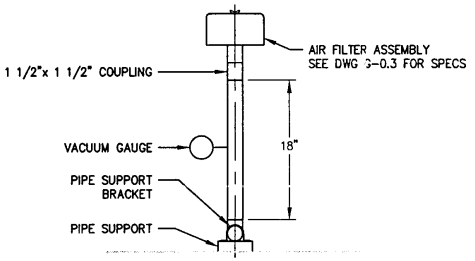


1 BLOWER PIPING LAYOUT PLAN DETAIL

3/4" = 1'-0"

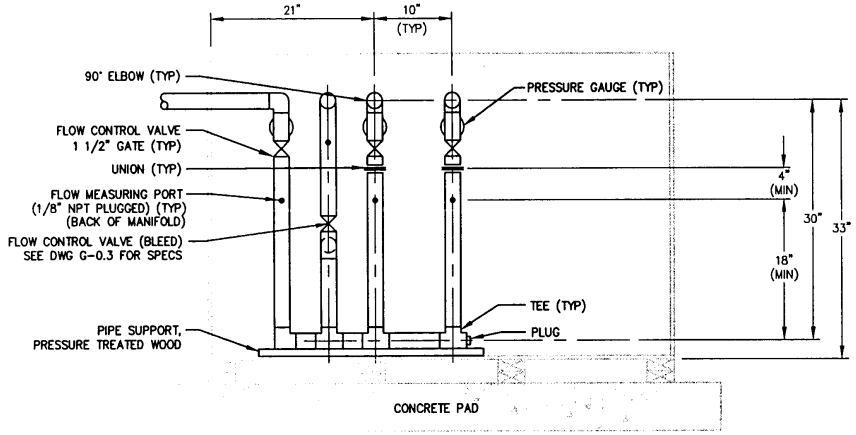
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 1 1/2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.5 FOR BLOWER BUILDING DETAILS



B BLOWER INLET PIPING SECTION

3/4" = 1'-0"



A MANIFOLD DETAIL SECTION

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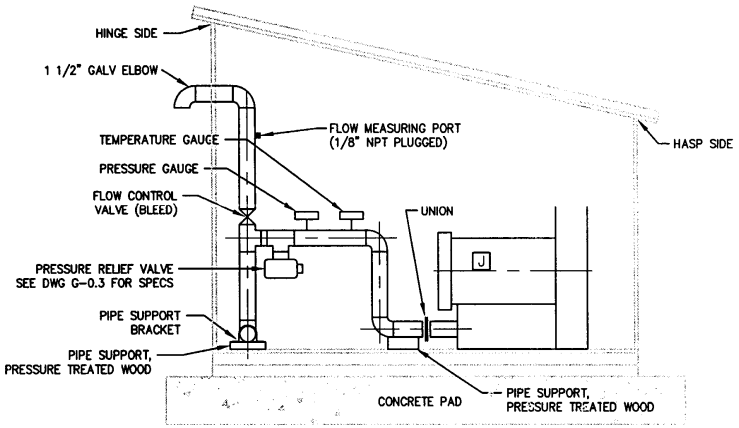

C BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

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Designed	SA				
Drawn	MW				
Checked					
Reviewed					
Approved		5/16/97	A	RECORD DRAWING	
Reg. No.			Rev	Date	Description
Date					By

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Denver, Colorado
(303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
FACILITIES 44625D AND E
CAPE CANAVERAL AIR STATION

BLOWER PIPING LAYOUT DETAIL

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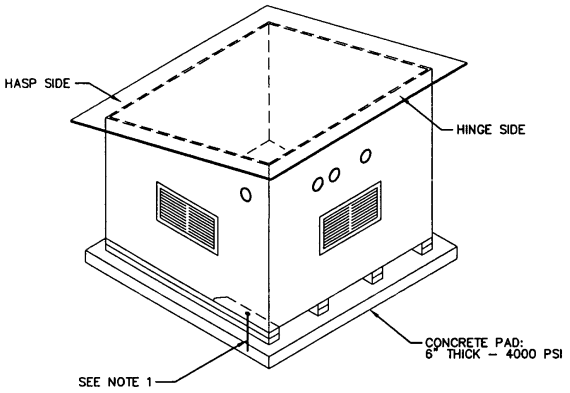
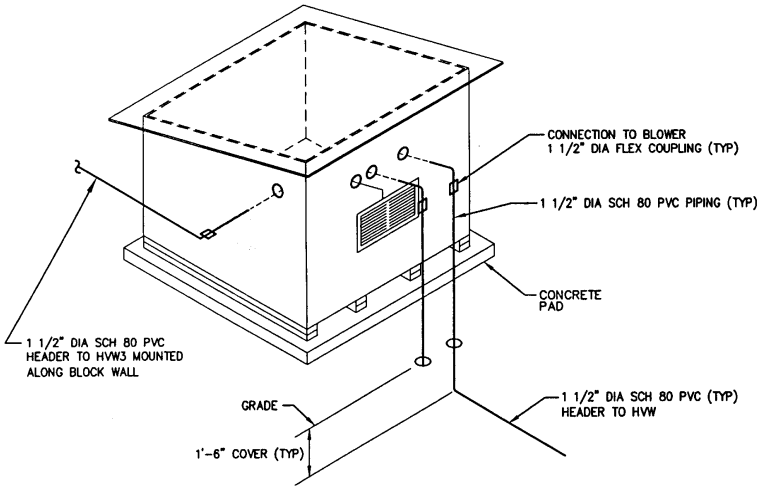


NOTES:
1. FIELD SECURE BLOWER SHED TO CONCRETE PAD AT 4 LOCATIONS BY THRU BOLTING. USE 3/8"x 6" LONG ST STL WEDGE ANCHOR BOLTS

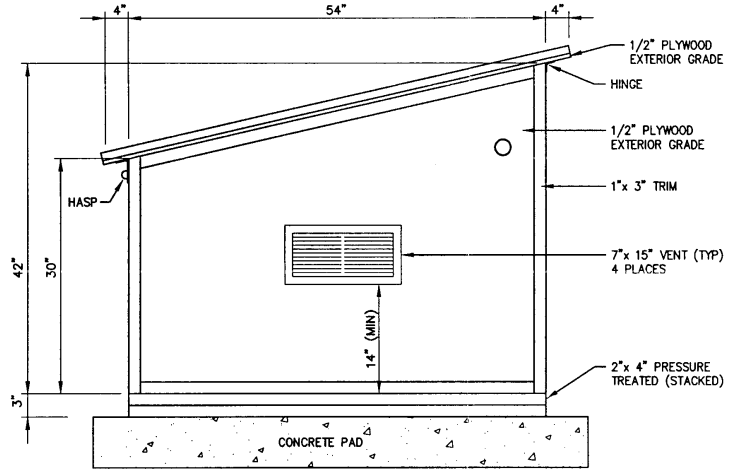
1/– BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE

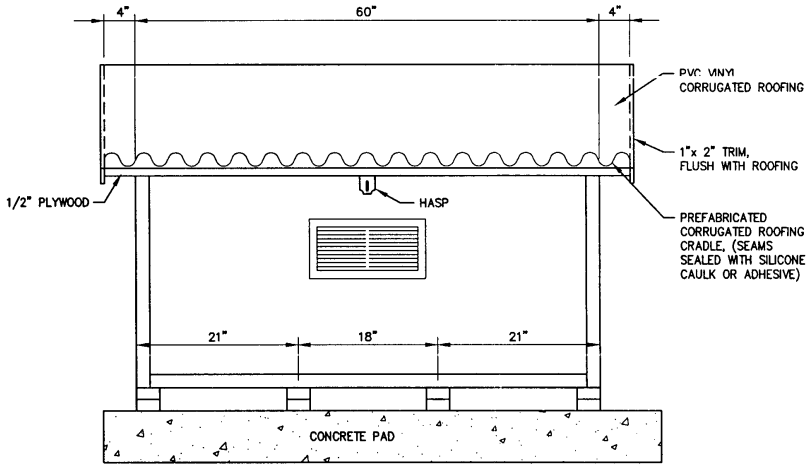


2/– TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE



SIDE ELEVATION



FRONT ELEVATION

NOTES:
1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

3/– BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

Job No. 726876.26242					
Designed SA					
Drawn MW					
Checked					
Reviewed					
Approved EAS		5/7/97			
Reg No	A	Rev	Date	Description	By
Date				RECORD DRAWING	

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
FACILITIES 44625D AND E
CAPE CANAVERAL AIR STATION

BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.5 | REV A

APPENDIX B

REGENERATIVE BLOWER INFORMATION

Gast Manufacturing Corp.
P.O. Box 97
Benton Harbor, MI 49023-0097
(616) 926-6171

Model R5125Q-50

Motor Specifications

Phase	HZ	HP	Voltage	Full Load Amps
1	50	2	115 / 230	25 / 12.5

Overall Dimensions

Height	Width	Depth	Net Weight
13.78 in 350 mm	15.50 in 445 mm	13.56 in 344 mm	77 lb 35 kg

Performance

Maximum Vacuum	Maximum Pressure	Maximum Flow
60 inH20 149 mbar	55 inH20 137 mbar	160 cfm 272 m^3h

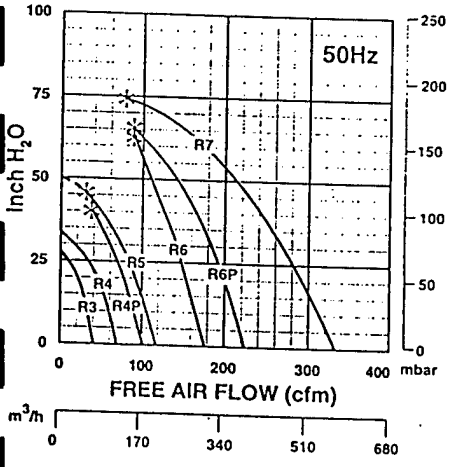
SOIL VAPOR EXTRACTION PUMPS – REGENERATIVE BLOWERS

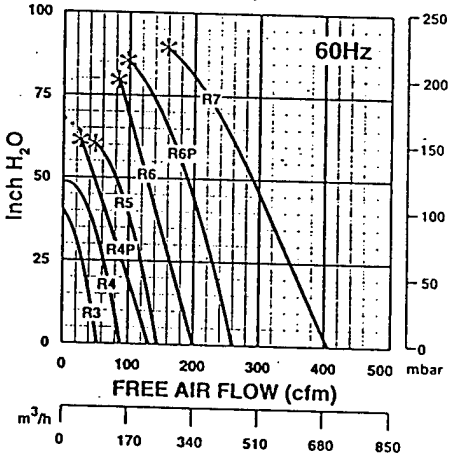
Product Specifications

Model Number	Motor Specifications					Max Vac		Max Pressure		Max Flow		Net. Wt.	
	Phase	Hz	Voltages	HP	Full Load Amps	"H_2O	mbar	"H_2O	mbar	cfm	m^3/h	lbs	kg
R3105N-50	Single	50	110/220-240	.33	3-8/1.9-2.0	28	70	31	77	43	73	52	24
		60	115/208-230	0.5	5.2/2.9-2.6	40	100	43	107	53	90		
R4110N-50	Single	50	110/220-240	0.6	9.2/5.2-4.6	35	87	38	95	74	126	60	28
		60	115/208-230	1.0	11.4/6.2-5.6	48	120	51	127	92	156		
R4310P-50	Three	50	220/380	0.6	3.2/1.6	35	87	38	95	74	126	58	27
		60	208-230/460	1.0	3.4-3.3/1.65	48	120	51	127	92	156		
R4P115N-50	Single	50	110/220-240	1.0	15.2/7.6-8	40	100	45	112	112	190	79	36
		60	115/208-230	1.5	18.2/9.7-9.1	60	149	65	162	133	226		
R5125Q-50	Single	60	115/230	2.0	25/12.5	60	149	55	137	160	272	77	35
R5325R-50	Three	50	190-220/380-415	1.5	5.0-4.4/2.5-2.6	47	117	50	125	133	226	75	34
		60	208-230/460	2.0	6.0-5.6/2.8	60	149	65	162	160	272		
R6130Q-50	Single	50	220-240	2.5	14.7-13.5	65	162	75	187	182	309	129	59
		60	230	3.0	16.3	70	174	60	149	215	365		
R6340R-50	Three	50	190-220/380-415	3.0	14.4-13.4/7.2-6.8	65	162	75	187	180	306	112	51
		60	208-230/460	4.0	13-12/6	80	199	100	249	215	365		
R6P155Q-50	Single	50	220-240	4.0	20.8-19.1	65	162	80	199	235	399	243	110
		60	230	5.5	29.9	85	212	95	237	280	476		
R6P355R-50	Three	50	190-220/380-415	4.5	14.9-11/7.45-5.8	65	162	80	199	232	394	233	105
		60	208-230/460	6.0	20-18/9	85	212	100	249	280	476		
R7100R-50	Three	50	190-220/380-415	8.0	20.8-18.9/10.4-9.5	72	179	80	199	350	595	297	134
		60	208-230/460	10.0	26.5-24/12	90	224	90	224	420	714		

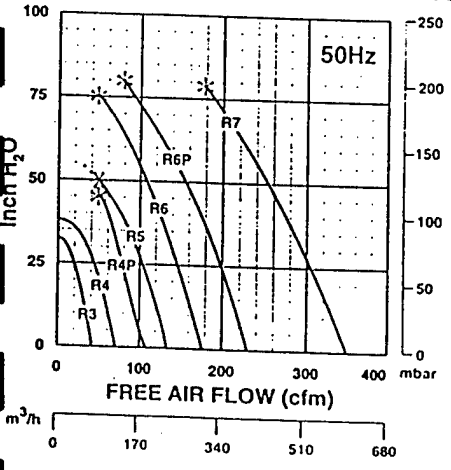
NOTICE: Performance specifications subject to change without notice.

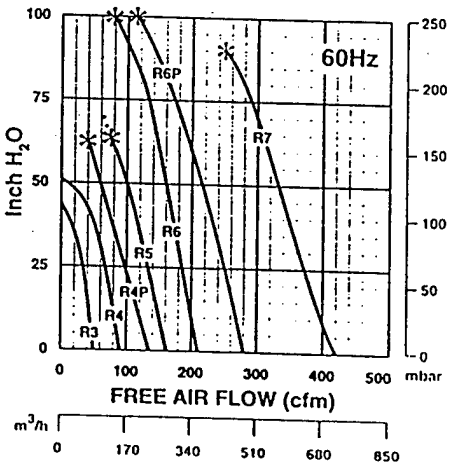
VACUUM





PRESSURE





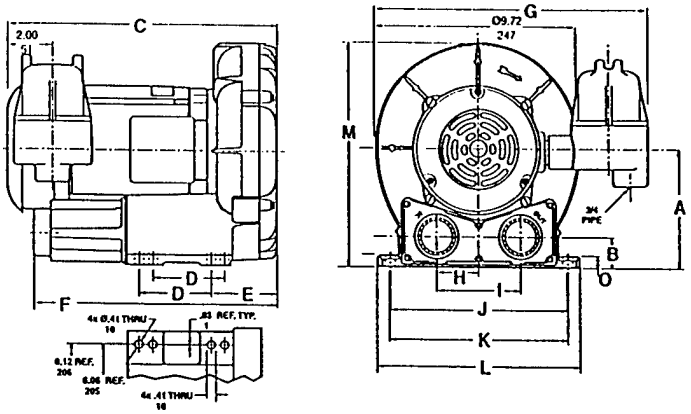
Free software identifies best Gast blowers for soil and groundwater remediation

Now you can size and select regenerative blowers and accessories for soil and groundwater remediation systems faster, easier and more accurately than ever before. Gast remediation system engineering software does the job and it is yours for the asking. The 3-½-inch IBM-compatible disk calculates performance when the blower is operating with both a vacuum and pressure load at the same time. The programs will also compensate for changes in performance from altitude and temperature, helping you identify the optimum Gast blowers for your application.

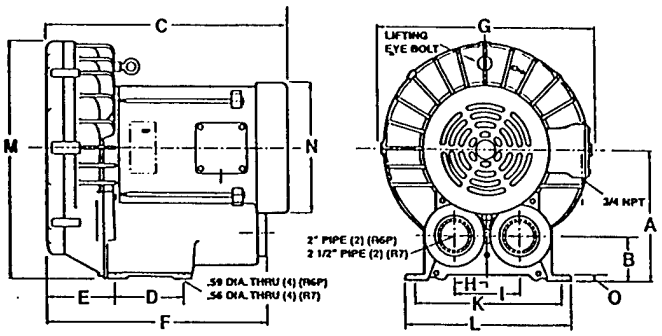
Call 1-800-952-4278 to receive your free remediation system engineering software

SOIL VAPOR EXTRACTION PUMPS – REGENERATIVE BLOWERS

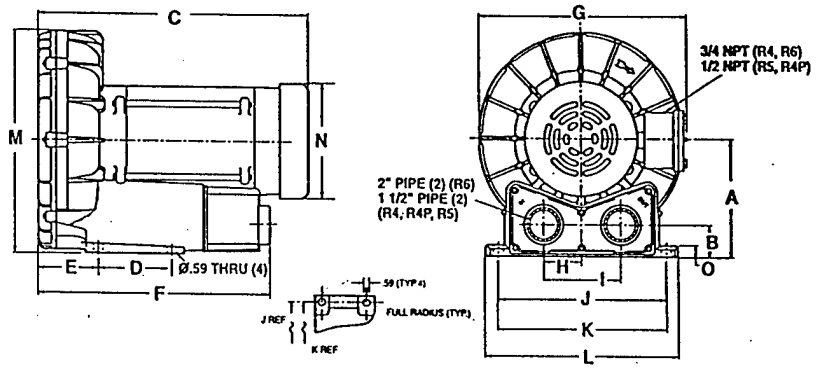
Model R3



Models R6P, R7



Models R4, R4P, R5, R6

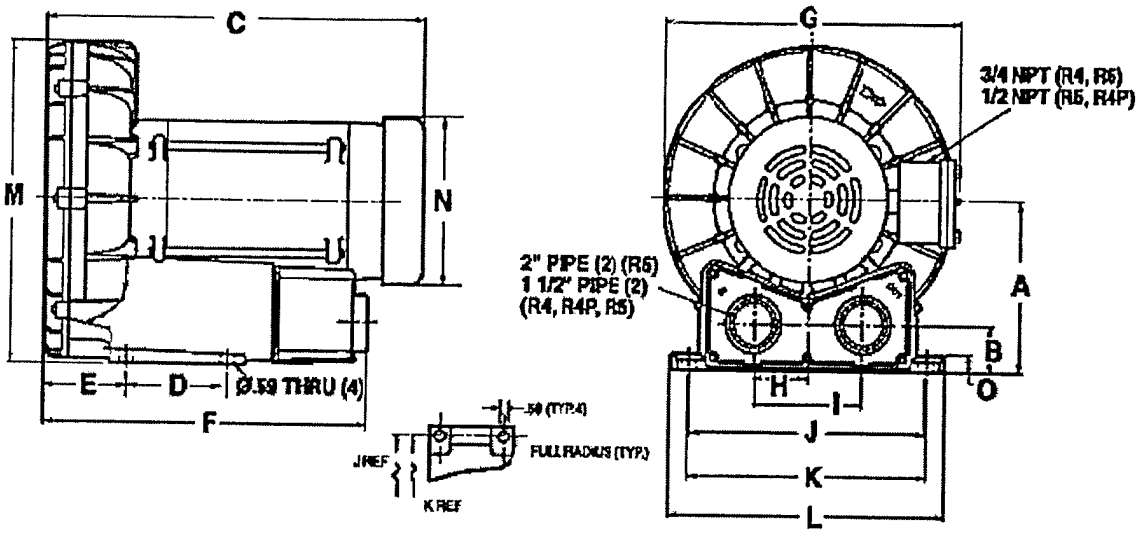


Product Dimensions Metric (mm) U.S. Imperial (inches)

Model	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
R3105N-50	131	35	310	83	80	281	324	49	99	205	206	238	258	-	13
	5.17	1.37	12.20	3.25	3.03	11.06	12.75	1.94	3.88	8.06	8.12	9.38	10.15	-	.53
R4110N-50	157	43	389	95	72	316	313	50	101	225	227	254	293	175	11
	6.18	1.68	15.30	3.75	2.85	12.44	12.31	1.98	3.96	8.86	8.93	10.00	11.73	6.88	.44
R4310P-50	157	43	356	95	72	316	313	50	101	225	227	254	293	175	11
	6.18	1.68	14.03	3.75	2.84	12.44	12.31	1.98	3.96	8.86	8.93	10.00	11.73	6.88	.44
R4P115N-50	177	47	442	114	83	354	338	60	121	260	262	298	346	175	15
	6.98	1.84	17.41	4.50	3.25	13.93	13.31	2.38	4.75	10.25	10.31	11.75	13.6	6.88	.60
R5125Q-50	178	46	445	114	91	361	344	60	121	260	262	298	350	173	15
	7.00	1.82	17.50	4.50	3.58	14.22	13.56	2.38	4.75	10.25	10.31	11.75	13.78	6.81	.59
R5325R-50	178	46	423	114	91	361	344	60	121	260	262	298	350	183	15
	7.00	1.82	16.66	4.50	3.58	14.22	13.56	2.38	4.75	10.25	10.31	11.75	13.78	7.19	.59
R6130Q-50	197	49	511	140	98	404	389	62	125	289	290	329	391	217	13
	7.75	1.94	20.13	5.50	3.85	15.89	15.30	2.46	4.92	11.38	11.42	12.96	15.38	8.56	.52
R6340R-50	197	49	478	140	98	404	385	62	125	289	290	329	390	217	13
	7.75	1.94	18.82	5.50	3.85	15.89	15.17	2.46	4.92	11.38	11.42	12.96	15.34	8.56	.52
R6P155Q-50	248	80	602	140	137	438	428	64	127	-	290	325	463	257	13
	9.77	3.15	23.7	5.51	5.39	17.25	16.87	2.50	5.00	-	11.42	12.80	18.21	10.12	.50
R6P355R-50	248	80	554	140	137	438	428	64	127	-	290	325	463	257	13
	9.77	3.15	21.80	5.51	5.39	17.25	16.87	2.50	5.00	-	11.42	12.80	18.21	10.12	.50
R7100R-50	274	92	577	216	212	545	457	100	200	-	375	410	509	257	14
	10.79	3.64	22.72	8.50	8.33	21.46	18.00	3.94	7.88	-	14.76	16.14	20.02	10.12	.56

Notice: Specifications subject to change without notice.

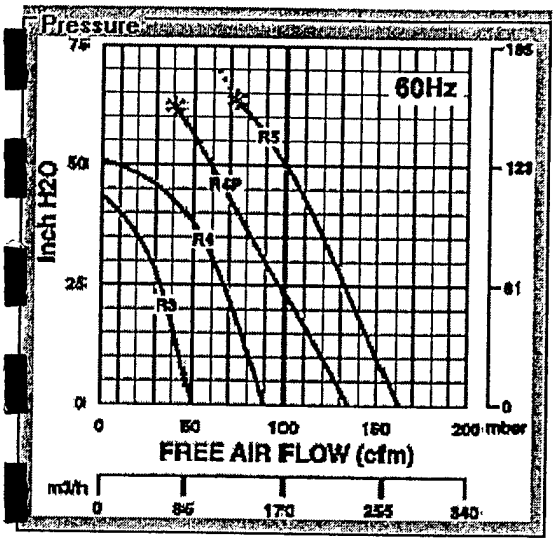
Model R5125Q-50

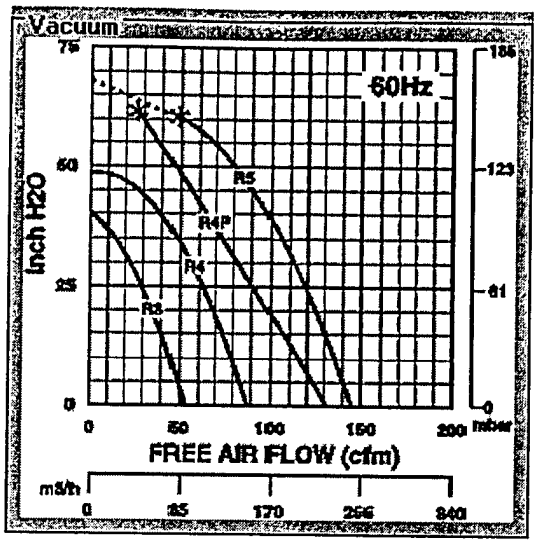


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
in.	7.00	1.82	15.30	4.50	3.66	11.22	13.35	2.38	3.75	10.25	11.25	12.25	12.28	5.12	1.50
mm.	178	46	345	114	93	285	341	60	121	260	286	311	312	130	38

Print Drawing | Close this Window

Model R5125Q-50





Print Curves

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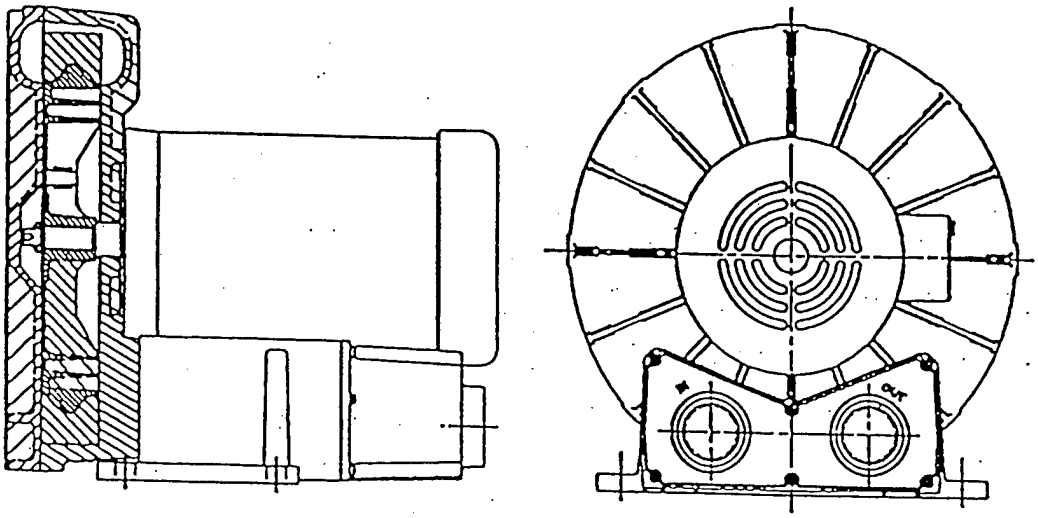
Maintenance Instructions for Gast Standard Regenerative Blowers



For original equipment manufacturers special models, consult your local distributor

Gast Rebuilding Centers

Gast Mfg. Corp.
2550 Meadowbrook Rd.
Benton Harbor MI. 49022
Ph: 616/926-6171
Fax: 616/925-8288

Gast Mfg Corp.
505 Washington Avenue
Carlstadt, N. J. 07072
Ph: 201/933-8484
Fax: 201/933-5545

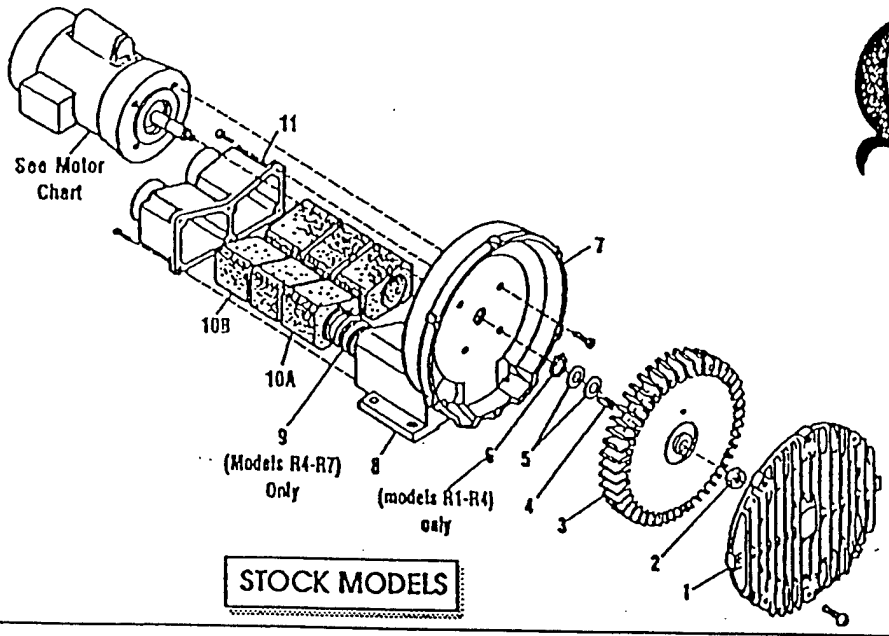
Brenner Fiedler. & Assoc.
13824 Bentley Place
Cerritos, CA. 90701
Ph: 213/404-2721
Fax: 213/404-7975

Wainbee, Limited
121 City View Drive
Toronto, Ont. Canada M9W 5A9
Ph: 416/243-1900
Fax: 416/243-2336

Wainbee, Limited
215 Brunswick Drive
Pointe Claire, P.Q. Canada H9R 4R7
Ph: 514/697-8810
Fax: 514/697-3070

Gast Mfg. Co. Limited.
Halifax Rd, Cressex Estate
High Wycombe, Bucks HP12 3SN
Ph. 44 494 523571
Fax: 44 494 436588

Japan Machinery Co. Ltd.
Central PO Box 1451
Tokyo 100-91 Japan
Ph: 813/3573-5421
Fax: 813/3571-7865



STOCK MODELS

Part Name	R1	R2	R3	R4	R5	R6	R6P	R6PP/R6PS	R7
#1 Cover	AJ101A	AJ101B	AJ101C	AJ101D	AJ101EQ	AJ101F	AJ101K	(2)AJ101KA	AJ101G
#2 Slopnut	BC187	BC187	BC181	BC181	BC181	BC181	BC181	(2)BC182	BC183
#3 Impeller	AJ102A	AJ102BQ	AJ102C	AJ102D	AJ102E	AJ102FR	AJ102K	(2)AJ102KA	AJ102GA
#4 Square Key	AH212C	AH212	AB136A	AB136D	AB136	AB136	AB136	(2)AB136	AC628
#5 Shim Spacer (s)	AJ132	AE686-3	AJ109	AJ109	AJ109	AJ116A	AJ116A	AJ116A	AJ110
#6 Retaining Ring	AJ145	AJ145	AJ149	AJ149					
#7 Housing	AJ103A	AJ103BQ	AJ103C	AJ103DR	AJ103E	AJ103F	AJ103K	AJ103KD	AJ103GA
#8 Muffler Box					AJ104E	AJ104F			
#9 Spring				AJ113DR	AJ113DQ	AJ113FQ	AJ113FQ		AJ113G
#10A Foam	(4)AJ112A	(4)AJ112B	(4)AJ112C	(4)AJ112DS	(4)AJ112ER	(6)AJ112F	(8)AJ112K		(8)AJ112GA
#10B Foam		(2)AJ112BQ	(2)AJ112CQ	(2)AJ112DR	(2)AJ112EQ				
#11 Muffler Extension/ Adapter Plate	AJ106H	AJ106BQ	AJ106CQ	AJ106DQ	AJ106EQ	AJ106FQ	AJ104K		AJ104GA
Shim Kit	K396	K396							K395

MOTOR CHART

REGENAIR MODEL NUMBER	MOTOR NUMBER	MOTOR SPECIFICATIONS 60 HZ VOLTS	50 HZ VOLTS	PHASE
R1102	J111X	115/208-230	110/220-240	1
R1102C	J112X	115		1
R2103	J311X	115/208-230	110/220	1
R2105	J411X	115/208-230	110/220	1
R2303A	J310	208-230/460	220/380-415	3
R2303F	J313	208-230	220	3
R3105-1/R3105-12	J411X	115/208-230	110/220-240	1
R3305A-1/R3305A-13	J410	208-230/460	220/380-415	3
R4110-2	J611AX	115/208-230	110/220-240	1
R4310A-2	J610	208-230/460	220/380-415	3
R5125-2	J811X	115/208-230		1
R5325A-2	J810X	208-230/460	220/380-415	3
R6125-2	J811X	115/208-230		1
R6325A-2	J810X	208-230/460	220/380-415	3
R6335A-2	J910X	208-230/460	220/380-415	3
R6150J-2	J1013	230		1
R6360A-2	J1010	208-230/460	220/380-415	3
R6P335A	J910X	208-230/460	220/380-415	3
R6P350A	J1010	208-230/460	220/380-415	3
R6P355A	J1110A	208-230/460	220/380-415	3
R7100A-2	J1210B	208-230/460	220/380-415	3
R6PP/R6PS3110M	JD1100	208-230/460	220/380-415	3

* No lubrication needed at start up. Bearings lubricated at factory.

* Motor is equipped with alemite fitting. Clean tip of fitting and apply grease gun. Use 1 to 2 strokes of high quality ball bearing grease.

Consistency	*Type*	*Typical Grease*
Medium	Lithium	Shell Dolium R

Hours of service per year	*Suggested Relube Interval*
5,000	3 years
Continual Normal Application	1 year
Seasonal service motor idle for 6 months or more	1 year beginning of season 6 months
Continuous-high ambients, dirty or moist applications.	

All performance figures relate to stock models. A few high pressure units may be available. Consult your local distributor.

Regenair Model Number	PRESSURE 0"H_2O	20"H_2O	40"H_2O	60"H_2O	80"H_2O	100"H_2O	Maximum Pressure "H_2O*
R1	26	14					28
R2	42	26					38
R3105-1	52	38	14				42
R3105-12	52	36	23				55
R3305A-13	52	36	23				55
R4	90	70	50				52
R5	145	130	100				65
R6125-2	200	180					35
R6325A-2	200	180	152				40
R6335A-2	205	175	155	135			70
R6350A-2	200	180	150	130	110	80	105
R6P335A	290	250					30
R6P350A	300	260	230	200			60
R6P355A	300	260	230	200	160		90
R7100A-2	420	380	340	310	280	230	115
R6PP311OM	485	452	420	380	330		95
R6PS311OM	265	258	252	244	236	226	170

Regenair Model Number	VACUUM 0"H_2O	20"H_2O	40"H_2O	60"H_2O	80"H_2O	Maximum Vacuum "H_2O*
R1	25	14				26
R2	40	22				34
R3105-1	50	34	9			40
R3105-12	51	34	20			50
R3305A-13	51	34	20			50
R4	82	62	39			48
R5	140	115	90	50		60
R6125-2	190	155	125			45
R6325A-2	190	155	125			45
R6335A-2	190	150	125	100		75
R6350A-2	190	180	150	100	70	90
R6P335A	270	230				37
R6P350A	280	240	210	170		70
R6P355A	280	240	210	170	100	86
R7100A-2	410	350	300	250	170	90
R6PP311OM	470	425	375	320	220	80
R6PS311OM	240	225	210	195	175	130

*This number indicates the maximum static pressure differential recommended (with cooling air still flowing through unit). In general, units 1hp or less can be dead headed. Check with local representative or distributor to verify which models apply.

Operation of the blower above the recommended maximum duty will cause premature failure due to the build up of heat damaging the components.

Performance data was determined under the following conditions:

1) Unit in a temperature stable condition.
2) Test conditions: Inlet air density at 0.075lbs. per cubic foot. (20°C(68°F), 29.92 in. Hg(14.7PSIA)).
3) Normal performance variations on the resistance curve within +/- 10% of supplied data can be expected.
4) Specifications subject to change without notice.
5) All performance at 60Hz operation.

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A113C 70-6100
F2-205/8/92
Rev. E

INSTALLATION AND OPERATING INSTRUCTIONS FOR GAST HAZARDOUS DUTY REGENAIR BLOWERS

This instruction applies to the following models ONLY: R3105N-50, R4110N-50, R4310P-50, R4P115N-50, R5125Q-50, R5325R-50, R6130Q-50, R6P155Q-50, R6350R-50, R6P355R-50 and R7100R-50.

Gast Authorized Service Facilities are Located in the locations listed below

Gast Manufacturing Corporation
505 Washington Avenue
Carlstadt, N. J. 07072
Ph: 201/933-8484
Fax: 201/933-5545

Gast Manufacturing Corporation
2550 Meadowbrook Road
Benton Harbor, MI. 49022
Ph: 616/926-6171
Fax: 616/925-8288

Brenner Fiedler & Associates
13824 Bentley Place
Cerritos, CA. 90701
Ph: 310/404-2721
Ph: 800/843-5558
Fax: 310/404-7975

Wainbee Limited
215 Brunswick Blvd.
Pointe Claire, Quebec
Canada H9R 4R7
Ph: 514/697-8810
Fax: 514/-697-3070

Wainbee Limited
5789 Coopers Ave.
Mississauga, Ontario
Canada L4Z 3S6
Ph: 416/243-1900
Fax: 416/243-2336

Japan Machinery
Central PO Box 1451
Toyko 100-91, Japan
Ph: 813 3573-5421
Fax: 813 3571-7896

Gast Manufacturing Co. Ltd.
Halifax Road, Cressex Estate
High Wycombe, Bucks HP12 3SN
England
Ph: 44 494 523571
Fax: 44 494 436588

OPERATING AND MAINTENANCE INSTRUCTIONS

SAFETY

This is the safety alert symbol. When you see this symbol personal injury is possible. The degree of injury is shown by the following signal words:

⚠ DANGER Severe injury or death will occur if hazard is ignored.

⚠ WARNING Severe injury or death can occur if hazard is ignored.

⚠ CAUTION Minor injury or property damage can occur if hazard is ignored.

Review the following information carefully before operating.

GENERAL INFORMATION

This instruction applies to the following models ONLY: R3105N-50, R4110N-50, R4310P-50, R4P115N-50, R5125Q-50, R5325R-50, R6130Q-50, R6P155Q-50, R6350R-50, R6P355R-50 and R7100R-50. These blowers are intended for use in Soil Vapor Extraction Systems. The blowers are sealed at the factory for very low leakage. They are powered with a U.L. listed electric motor Class 1 Div. 1 Group D motors for Hazardous Duty locations. Ambient temperature for normal full load operation should not exceed 40° C (105° F). For higher ambient operation, contact the factory.

Gast Manufacturing Corporation may offer general application guidance: however, suitability of the particular blower and/or accessories is ultimately the responsibility of the user, not the manufacturer of the blower.

INSTALLATION

⚠ *DANGER Models R5325R-50, R6130Q-50, R6350R-50, R5125Q-50, R6P155Q-50, R6P355R-50 AND R7100R-50 use Pilot Duty Thermal Overload Protection. Connecting this protection to the proper control circuitry is mandated by UL674 and NEC501. Failure to do so could/may result in a EXPLOSION. See pages 3 and 4 for recommended wiring schematic for these models.*

⚠ *WARNING Electric shock can result from bad wiring. A qualified person must install all wiring, conforming to all required safety codes. Grounding is necessary.*

⚠ *WARNING This blower is intended for use on soil vapor extraction equipment. Any other use must be approved in writing by Gast Manufacturing. Corp.* Install this blower in any mounting position. Do not block the flow of cooling air over the blower and motor.

PLUMBING - Use the threaded pipe ports for connection only. They will not support the plumbing. Be sure to use the same or larger size pipe to prevent air flow restriction and overheating of the blower. When installing fittings, be sure to use pipe thread sealant. This protects the threads in the blower housing and prevents leakage. Dirt and chips are often found in new plumbing. Do not allow them to enter the blower.

NOISE - Mount the unit on a solid surface that will not increase the sound. This will reduce noise and vibration. We suggest the use of shock mounts or vibration isolation material for mounting.

ROTATION - The Gast Regenair Blower should only rotate clockwise as viewed from the electric motor side. The casting has an arrow showing the correct direction. Confirm the proper rotation by checking air flow at the IN and OUT ports. If needed reverse rotation of three phase motors by changing the position of any two of the power line wires.

OPERATION

⚠ *WARNING Solid or liquid material exiting the blower or piping can cause eye damage or skin cuts. Keep away from air stream.*

⚠ *WARNING - Gast Manufacturing Corporation will not knowingly specify, design or build any blower for installation in a hazardous, combustible or explosive location without a motor conforming to the proper NEMA or U. L. standards.* Blowers with standard TEFC motors should never be utilized for soil vapor extraction applications or where local state and/or Federal codes specify the use of explosion-proof motors (as defined by the National Electric Code, Articles 100,500 c1990).

⚠ *CAUTION Attach blower to solid surface before starting to prevent injury or damage from unit movement.* Air containing solid particles or liquid must pass through a filter before entering the blower. Blowers must have filters, other accessories and all piping attached before starting. Any foreign material passing through the blower may cause internal damage to the blower.

⚠ *CAUTION Outlet piping can burn skin. Guard or limit access.* Mark *"CAUTION Hot Surface. Can Cause Burns".* Air temperature increases when passing through the blower. When run at duties above 50 in. H_2O, metal pipe may be required for hot exhaust air. The blower must not be operated above the limits for continuous duty. Only models R3105N-50, R4110N-50 and R4310P-50 can be operated continuously with no air flowing through the blower. Other units can only be run at the rating shown on the model number label. Do not Close off inlet (for vacuum) to reduce extra air flow. This will cause added heat and motor load. Blower exhaust air in excess of 230°F indicates operation in excess of rating which can cause the blower to fail.

ACCESSORIES ...Gast pressure gauge AJ496 and vacuum gauges AJ497 or AE134 show blower duty. The Gast pressure/vacuum relief valve, AG258, will limit the operating duty by admitting or relieving air. It also allows full flow through the blower when the relief valve closes.

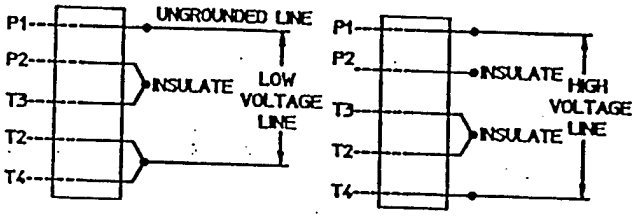
SERVICING

⚠ *WARNING To retain their sealed construction they should be serviced by Gast authorized service centers ONLY.* These models are sealed at the factory for very low leakage.

⚠ *WARNING Turn off electric power before removing blower from service. Be sure rotating parts have stopped. Electric shock or severe cuts can result.* Inlet and exhaust filters attached to the blower may need cleaning or replacement of the elements. Failure to do so will result in more pressure drop, reduced air flow and hotter operation of the blower. The outside of the unit requires cleaning of dust and dirt. The inside of the blower also may need cleaning to remove foreign material coating the impeller and housing. This should be done at a Gast Authorized Service Center. This buildup can cause vibration, failure of the motor to operate or reduced flow.

KEEP THIS INFORMATION WITH THIS BLOWER.
REFER TO IT FOR SAFE INSTALLATION,
OPERATION OR SERVICE.

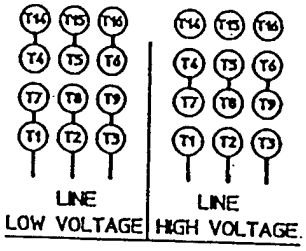
MOTOR WIRING DIAGRAM FOR R4110N-50 & R3105N-50



>>* WARNING
THIS MOTOR IS THERMALLY PROTECTED AND WILL AUTOMATICALLY RESTART WHEN PROTECTOR RESETS. ALWAYS DISCONNECT POWER SUPPLY BEFORE SERVICING.

MOTORS WIRING DIAGRAM FOR R4310P-50

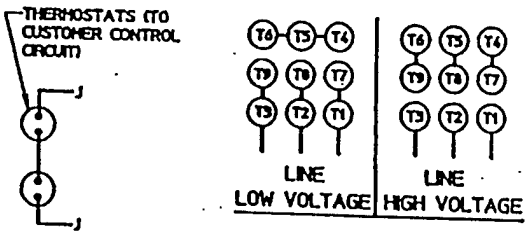
TO REVERSE ROTATION, INTERCHANGE THE EXTERNAL CONNECTIONS TO ANY TWO LEADS.



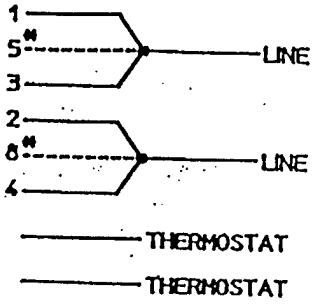
>>* WARNING
THIS MOTOR IS THERMALLY PROTECTED AND WILL AUTOMATICALLY RESTART WHEN PROTECTOR RESETS. ALWAYS DISCONNECT POWER SUPPLY BEFORE SERVICING.

MOTORS WIRING DIAGRAM FOR R5325R-50, R6350R-50, R6P355R-50, & R7100R-50

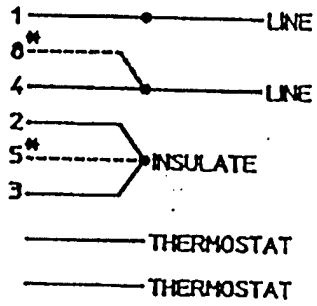
TO REVERSE ROTATION, INTERCHANGE THE EXTERNAL CONNECTIONS TO ANY TWO LEADS.



MOTOR WIRING DIAGRAM FOR R5125Q-50 & R4P115N-50



LOW VOLTAGE

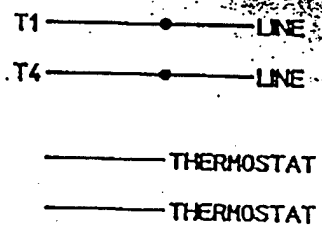


HIGH VOLTAGE

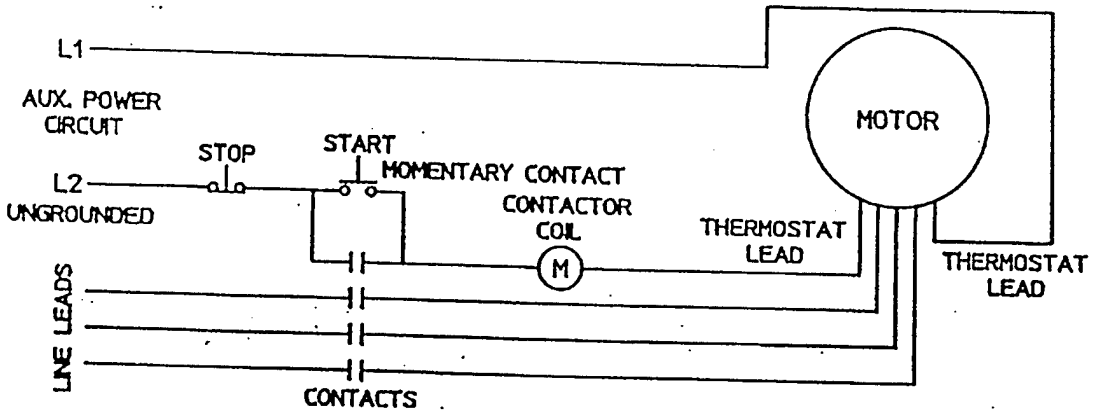
* R5125Q-50 BLOWERS PRODUCED AFTER SEPTEMBER 1992 (SER. NO. 0992) DO NOT HAVE MOTOR LEADS 5 & 8.

MOTOR WIRING DIAGRAM FOR R6130Q-50 & R6P155Q-50

CONNECT THERMOSTAT TO MOTOR PROTECTION CIRCUIT



CONNECTION FOR THERMOSTAT MOTOR PROTECTION



TERMOSTATS TO BE CONNECTED IN SERIES WITH CONTROL AS SHOWN. MOTOR FURNISHED WITH AUTOMATIC THERMOSTATS RATED A.C. 115-600V. 720VA

AK811 rev. E

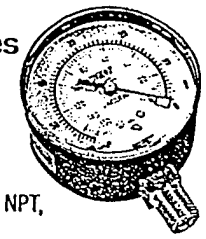
Blower Accessories

In-line Filters

The impeller of a blower passes very close to the housing. It is always wise to have an inlet or in-line filter to ensure troublefree life.

Model No.	R4	R5	R6,R6P	R7
Part No.	AJ151D	AJ151E	AJ151G	AJ151H
Replacement Element	AJ135E	AJ135F	AJ135G	AJ135C
Micron	10	10	10	10

Vacuum and Pressure Gauges



To monitor the system performance so as not to exceed maximum duties. Using two (one on each side of the filter) is a great way to know when the filter needs servicing.

- Vacuum Gauge, Part #AJ497, 2 5/8" Dia., 1/4" NPT, 0-60 in. H_2O and 0-150 mbar
- Vacuum Gauge, Part #AE134, 2 5/8" Dia., 1/4" NPT, 0-160 in. H_2O and 0-400 mbar
- Pressure Gauge, Part #AJ496, 2 5/8" Dia., 1/4" NPT, 0-60 in. H_2O and 0-150 mbar
- Pressure Gauge, Part #AE133, 2 5/8" Dia., 1/4" NPT, 0-160 in. H_2O and 0-400 mbar
- Pressure Gauge, Part #AE133A, 2 5/8" Dia., 1/4" NPT, 0-200 in. H_2O

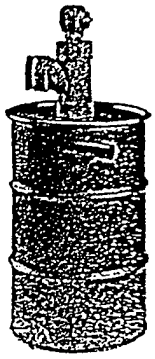
Horizontal Swing Type Check Valve

Designed to prevent back-wash of fluids that would enter the blower. Also prevents air back-streaming if needed. They can be mounted with their discharge either vertical or horizontal. Valve will open with 3" of water pressure.

Model No.	R4,R5	R6,R6P	R7
Part No.	AH326D	AH326F	AH326G
	1 1/2" NPT	2" NPT	2 1/2" NPT

Moisture Separator

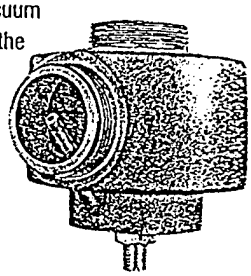
The purpose of the moisture separator is to remove liquids from the gas stream in a soil vapor extraction process. This helps protect the blower from corrosion and a build up of mineral deposits.



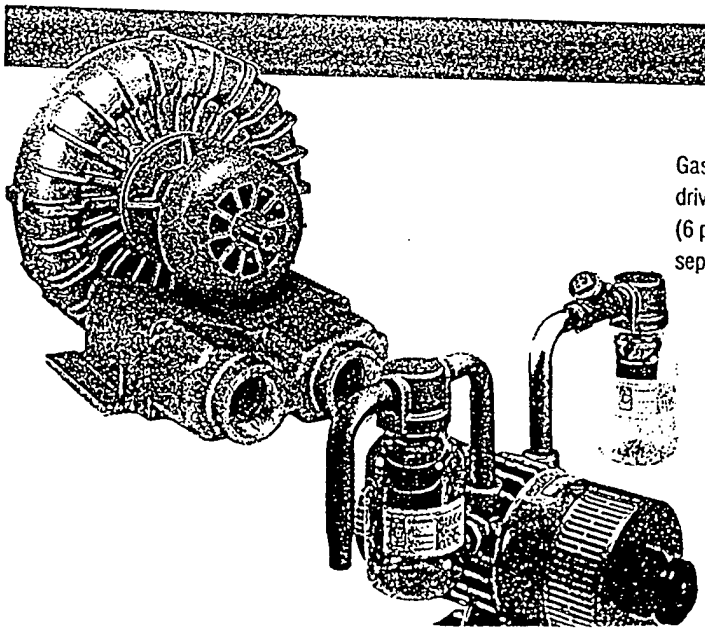
MODEL	LIQUID CAPACITY GALLONS	USED ON
RMS160	10	R4, R4P, R5
RMS200	19	R4, R4P, R5, R6
RMS300	19	R5, R6, R6P
RMS400	40	R6P, R7

Relief Valve

By setting a relief valve at a given pressure/vacuum you can be assured that no harm will come to the blower or products in your application from excessive duties.



- Pressure/Vacuum Relief Valve, 1 1/2" NPT, Adjustable 30 - 170 in. H_2O, 200 cfm max. Part #AG258



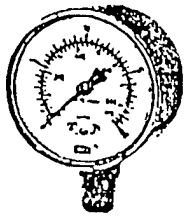
Gast also offers other models that are ideal for soil sparging. Our separate drive blowers are available in 4 sizes to 15 hp, pressures to 170" H_2O (6 psi). Rotary vane compressors are available in motor mounted or separate drive styles up to 5 hp, pressures to 20 psi.

LOW PRESSURE GAUGES
Types 611.10 & 612.20

WIKA INSTRUMENT CORPORATION
1000 Wiegand Boulevard
Lawrenceville, Georgia 30243-5868
(404) 513-8200 1-800-645-0606
FAX: (404) 513-8203

PRICE LIST

Type 611.10 2 ½" (63mm)
Type 612.20 4" (100mm)



Standard Features

Case: Black painted steel (611.10)
Stainless steel (612.20)
Bayonet Ring: None (2½")
Stainless steel (4")
Wetted Parts: Copper alloy
Window: Acrylic (2½")
Instrument glass (4")
Dial: White aluminum
Pointer: Black aluminum
Accuracy: ± 1.5% of span

Brass movement with highly polished bearing surfaces

Recalibration screw on dial

Special Order Options

50 pcs. minimum order quantity per line item required (611.10)
25 pcs. minimum order quantity per line item required (612.20)

Custom Dials - Special scales and dial markings are available. Standard list prices apply. Add any applicable artwork/set-up charges. Refer to "Custom Dial Artwork Charges" (price page PL95-32).

Special Connections - No additional charge for standard NPT or metric threads. Contact factory for other special threads.

Gauge Accessories - Additional accessories may be available. Refer to "Pressure Gauge Accessories" (price page PL95-30).

Additional Options Available -

Nickel or chrome plated connection
Lower back mount (Type 612.20 only)
Rear flange
U-clamp
Safety glass window
Stainless steel wetted parts 2½" (631.10)
Stainless steel wetted parts 4" (632.50)
(refer to price page PL95-21 for prices)
Cleaned for oxygen service
Stainless steel case and ring
Red drag pointer

Type	611.10		612.20
Size	2 ½"		4"
Connection	LM	CBM	LM
Conn. Size	1/4" NPT		
Data Sheet	APM 06.01		APM 06.02
List Price	$43.25	$47.55	$139.15
Vacuum Range (dual scale)			
inch water / mm water			
0-30 / 0-760	9852344	9851852	9747724
0-60 / 0-1500	9748321	9748339	
0-100 / 0-2500	9747473	9747465	
Pressure Ranges (dual scale)			
inch water / mm water			
0-15 / 0-380	9851682	9851860	9747732
0-30 / 0-760	9851690	9855785	9747740
0-60 / 0-1500	9851704	9803432	9747758
0-100 / 0-2500	9851810	9851879	9747766
0-200 / 0-5000	9851828	9851887	9747775
oz./sq. in. / mm water			
0-10 / 0-440	9851771		
0-15 / 0-660	9851780		
0-20 / 0-880	9851798		
0-30 / 0-1320	9851747	9851917	
0-35 / 0-1540	9851801	9857273	
0-60 / 0-2640	9851755	9803548	
oz./sq. in. / in. water			
0-20 / 0-34	9851720	9857281	
0-32 / 0-55	9851739	9855793	
Pressure Ranges (single scale)			
psi			
3	9851925	9851836	9747783
5	9851933	9851844	9747791
Accessories (installed)			
Accessory prices do not apply to orders of 50 pcs or more per line item (25 pcs. for type 612.20). Contact factory for quote.			
FF, chrome plated brass	$27.55	$21.55	N/A
	1327085	1327087	
FF, black painted steel	$21.30	$24.55	N/A
	1327089	1327091	
FF, stainless steel	--	--	$23.65
			1327081
Restrictor, brass	$.90		
	1326943		

ABBREVIATIONS
LM - Lower Mount
CBM - Center Back Mount
FF - Front Flange
N/A - Not Available

In keeping with and for purposes of product improvement, WIKA reserves the right to make design changes without prior notice.

- Items with part numbers are available from stock (subject to prior sale).
- Please use applicable part numbers when ordering.
- Items shown without part numbers are available on special order at no additional charge. Above listed minimum order quantities per line item required. Contact factory for current lead times.

Prices subject to change without notice.
This price list supersedes price list dated 01/01/95.
Effective 03/01/95 cr
Price Page PL95-20

Prices: FOB Lawrenceville, GA
Terms: 30 days net
(subject to credit approval)

Warranty

REGARDLESS OF CAUSE, if a product you buy from this brochure does not work right, Gast will repair or replace it once, at no charge, for up to one year from the date of shipment from the factory. In the course of repair or replacement, Gast may send you written recommendations on how to prevent a problem from happening again. Gast reserves the right to withdraw this warranty if you do not follow these recommendations. Customer is responsible for freight charges both to and from Gast in all cases. This warranty does not apply to electric motors, electrical controls, and gasoline engines, which Gast obtains from other manufacturers. A motor or engine carries only the warranty of the company that makes it.

THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, INCLUDING THE WARRANTY OF MERCHANTABILITY AND OF FITNESS FOR ANY PARTICULAR PURPOSE. GAST'S LIABILITY IS IN ALL CASES LIMITED TO THE REPLACEMENT PRICE OF ITS PRODUCT. GAST SHALL NOT BE LIABLE FOR ANY OTHER DAMAGES, WHETHER CONSEQUENTIAL, INDIRECT, OR INCIDENTAL, ARISING FROM THE SALE OR USE OF ITS PRODUCTS.

Gast's sales personnel may modify this warranty, but only by signing a specific, written description of any modifications.

DISCLAIMER

The information presented in this catalog is based on technical data and test results of nominal units. It is believed to be accurate and is offered as an aid in the selection of Gast products. It is the user's responsibility to determine suitability of the product for his intended use and the user assumes all risk and liability whatsoever in connection therewith.

North American Representatives and Distributors

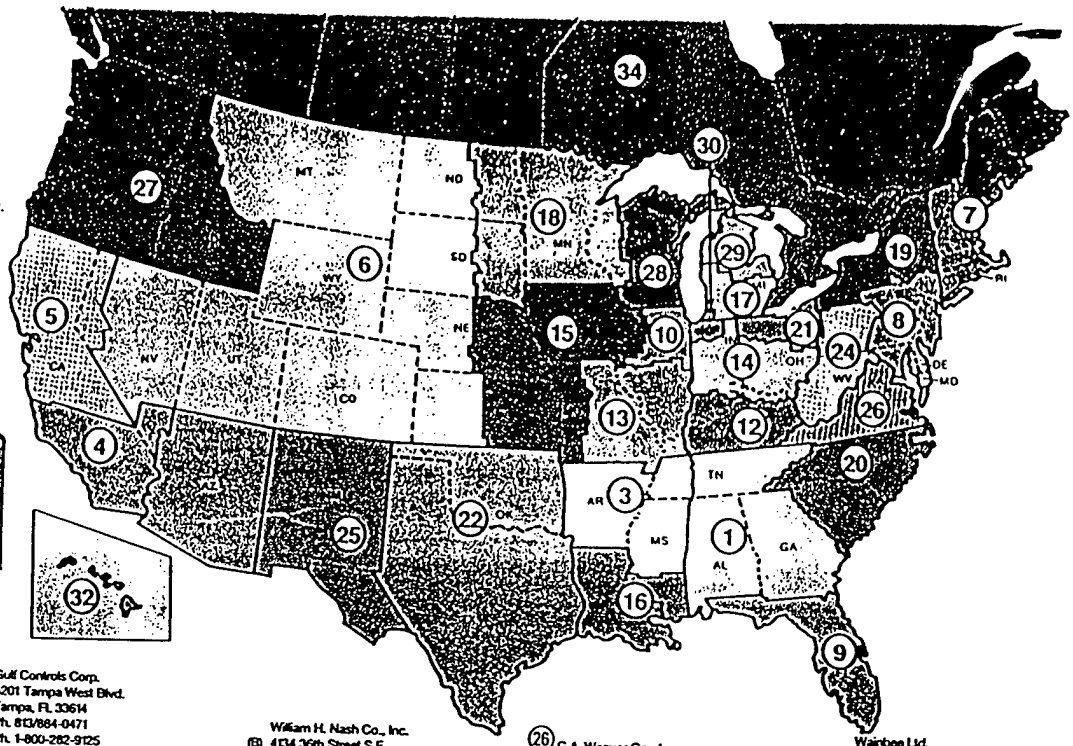
A substantial stock of vacuum pumps, compressors, air motors, parts and accessories are carried by the offices listed below.

(A) Distributor–plant-use sales only.

(B) Manufacturers Representative – O.E.M. and plant-use sales.

(C) Gast warehouse and sales office – O.E.M. and plant-use sales.

(D) Gast service center.



(1) James E. Watson & Co.
(B) 29 Doran Ave.
Marietta, GA 30060
Ph. 404/422-1154

James E. Watson & Co.
Birmingham, AL
Ph. 205/663-6678

James E. Watson & Co.
Nashville, TN
Ph. 615/331-5716

(3) Franklin Electrofluid Co., Inc.
(B) 3854 Watman
Memphis, TN 38118
Ph. 901/362-7504
Ph. 1-800-238-7500

Franklin Electrofluid Co., Inc.
(B) 8900 Crystal Hill Road
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AR only 1-800-272-5665
Ph. 501/771-4170

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Ph. 1-800-264-7406

(4) Brenner-Fiedler & Assoc., Inc.
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Cerritos, CA 90701
Ph. 310/404-2721 &
Ph. 714/521-6280
Ph. 1-800-843-5558

Brenner Fiedler & Assoc., Inc.
(B) San Diego, CA
Ph. 619/232-9152
Ph. 1-800-843-5558

Brenner Fiedler & Assoc., Inc.
(B) 2117 South 48th Street #102
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Ph. 1-800-638-0394

(5) TECO Pneumatic, Inc.
(B) 1069 Serpentine Lane
Pleasanton, CA 94566
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(6) Fiero Fluid Power, Inc.
(B) Suite 104
10515 East 40th Ave.
Denver, CO 80239
Ph. 303/373-2600

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(B) 2155 South Main
Salt Lake City, UT 84115
Ph. 801/467-4622

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Connecticut only 203/953-7632
New England States 1-800-858-9368

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(C,D) Eastern Sales Office
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Ph. 212/563-1870 (NYC)

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Die-A-Matic, Inc.
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Ph. 717/846-9300

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Ph. 215/923-2575

Van-Air & Hydraulics, Inc.
(A) 525 E. Woodlawn Ave.
Maple Shade, NJ 08052
Ph. 609/779-7300

(9) Gulf Controls Corp.
(B) 5201 Tampa West Blvd.
Tampa, FL 33614
Ph. 813/884-0471
Ph. 1-800-282-9125

(10) GAST
Gast Midwestern Sales Office
(C) 755 N. Edgewood
Wood Dale, IL 60191
Ph. 708/860-7477

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(13) John Henry Foster Co. Inc.
(B) 4700 Lebourget Drive
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(14) Isaacs Fluid Power Equipment Company
(B) 8746 East 33rd Street
Indianapolis, IN 46226
Ph. 317/898-3486

Isaacs Fluid Power Equipment Company
Ft. Wayne, IN
Ph. 219/747-9804

Isaacs Fluid Power Equipment Company
(B) 1023 E. Fourth St.
Dayton, OH 45402
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Isaacs Fluid Power Equipment Company
(B) 1840 Amberlawn Dr.
Cincinnati, OH 45237
Ph. 513/761-8855

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(B) 929 Eastwind Drive, Suite 205
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(15) Skarda Equipment Co., Inc.
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Ph. 216/464-8990

(22) Southwestern Controls
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Dallas, TX 75247
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San Antonio, TX 78216-4035
Ph. 210/340-4111

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(25) Mesa Equipment & Supply Company
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Albuquerque, NM 87109
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Ph. 703/563-9761

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Norfolk, VA 23513
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Fax: 206/762-4736

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Ph. 1-800-242-2672

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Eugene, OR 97401
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Ph. 414/337-0234

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New Berlin, WI 53151-2701
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West Branch, MI 48661
Ph. 517/345-1150

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(D) Benton Harbor, MI 49023-0097
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Ph. 808/682-1541

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Ph. 907/562-2933

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Ph. 613/744-1720

Wainbee Ltd.
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Mississauga, Ontario L4Z 3S6
Ph. 905/568-1700
Fax: 905/568-0083

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(B) Unit 14
65 Trillium Park Place
Kitchener, Ont. N2E 1X1
Ph. 519/748-5391

Wainbee Ltd.
(B) 1909 Oxford Street East, Unit 45
London, Ont. N5V 4L9
Ph. 519/451-6266
Fax: 519/451-5566

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Pointe Claire, P.Q. H9R 4R7
Ph. 514/697-8810

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Quebec City, P.Q. G1N 4K8
Ph. 418/683-1956

Wainbee Ltd.
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Ph. 418/698-4884

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Ph. 604/278-4288
Ph. 1-800-663-9829

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Ph. 403/236-1133

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Ph. 1-800-667-1787

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Saskatoon, Sask. S4S 0S9
Ph. 306/652-1433

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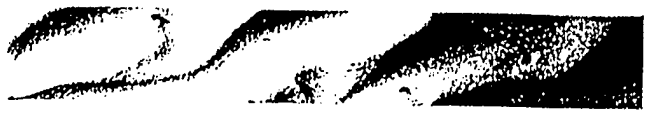
GAST®

CONVERSION CHARTS



PRESSURE CONVERSION TABLE

Lbs. Per Sq. Inch	Atmospheres	Inches of Mercury	Millimeters of Mercury	Inches of Water	Meters of Water	Milli Bars	Kilopascals
1	.0680	2.036	51.71	27.73	.7037	69.0	6.895
14.70	1	29.92	760	407	10.33	1013.3	101.36
.4912	.0334	1	25.4	13.6	.3452	33.86	3.387
.0193	.001315	.03937	1	.5358	.0136	1.33	.13307
.0361	.00246	.0735	1.868	1	.0254	2.49	.24891
1.422	.0967	2.895	73.55	39.37	1	97.98	9.8047
14.50	.0009869	.02953	.750	.4018	.01021	1	.09998
.145	.00986	.29529	7.4996	4.0174	.10206	10.01	1

VOLUME FLOW CONVERSION TABLE

cfm	cfh	gpm	m³h	l/s
1	60	7.4805	1.6990	.47195
1/60	1	.12468	.02832	.007866
.13368	8.0208	1	.22712	.06309
.58858	35.315	4.4029	1	1/3.6
2.1189	127.13	15.850	3.6	1

Power and Heat Flow Conversion Table

hp(U.S.)	ft.lb/min	Btu/hr	Btu/min	W	kcal/min
1	33000	2544.4	42.407	745.70	10.686
.000030303	1	.07710	.001285	.02260	.0003238
.0003930	12.969	1	1/60	.29307	.004200
.02358	778.17	60	1	17.584	.25200
.00134	44.254	3.4121	.05687	1	.01433
.09358	3088.0	238.10	3.9683	69.780	1

Temperature Conversion Chart

°C = ⅝ (°F -32)

Absolute Kelvin = °C +273.15

°F = (⅝°C) +32

Rankine °F = +459.67

TABLE EXAMPLE:
To Convert 100 °C to °F look up 100 read left
To Convert 100 °F to °C look up to 100 read right

to °F	From	to °C
-148.0	-100	-73.33
-130.0	-90	-67.78
-112.0	-80	-62.22
-94.0	-70	-56.67
-76.0	-60	-51.11
-58.0	-50	-45.56
-40.0	-40	-40.00
-36.4	-38	-38.89
-32.8	-36	-37.78
-29.2	-34	-36.67
-25.6	-32	-35.56
-22.0	-30	-34.44
-18.4	-28	-33.33
-14.8	-26	-32.22
-11.2	-24	-31.11
-7.6	-22	-30.00
-4.0	-20	-28.89
-0.4	-18	-27.78
+3.2	-16	-26.67
+6.8	-14	-25.56
+10.4	-12	-24.44
+14.0	-10	-23.33
+17.6	-8	-22.22
+21.2	-6	-21.11
+24.8	-4	-20.00
+28.4	-2	-18.89
+32.0	0	-17.78
+35.6	+2	-16.67
+39.2	+4	-15.56
+42.8	+6	-14.44
+46.4	+8	-13.33

to °F	From	to °C
+50.00	+10	-12.22
+53.6	+12	-11.11
+57.2	+14	-10.00
+60.8	+16	-8.89
+64.4	+18	-7.78
+68.0	+20	-6.67
+71.6	+22	-5.56
+75.2	+24	-4.44
+78.8	+26	-3.33
+82.4	+28	-2.22
+86.0	+30	-1.11
+89.6	+32	0.00
+93.2	+34	+1.11
+96.8	+36	+2.22
+100.4	+38	+3.33
+104.0	+40	+4.44
107.6	42	5.56
111.2	44	6.67
114.2	46	7.78
118.4	48	8.89
122.0	50	10.00
125.6	52	11.11
129.2	54	12.22
132.8	56	13.33
136.4	58	14.44
140.0	60	15.56
143.6	62	16.67
147.2	64	17.78
150.8	66	18.89
154.4	68	20.00
158.0	70	21.11

to °F	From	to °C
161.6	72	22.22
165.2	74	23.33
168.8	76	24.44
172.4	78	25.56
176.0	80	26.67
179.6	82	27.78
183.2	84	28.89
186.8	86	30.00
190.4	88	31.11
194.0	90	32.22
197.6	92	33.33
201.2	94	34.44
204.8	96	35.56
208.4	98	36.67
212.0	100	37.78
230.0	110	43.33
248.0	120	48.89
266.0	130	54.44
284.0	140	60.00
302.0	150	65.56
320.0	160	71.11
338.0	170	76.67
356.0	180	82.22
374.0	190	87.78
392.0	200	93.33
410.0	210	98.89
428.0	220	104.44
446.0	230	110.00
464.0	240	115.56
482.0	250	121.11

APPENDIX C

DATA COLLECTION SHEETS

DATA COLLECTION SHEET
REGENERATIVE BLOWER SYSTEM
FACILITIES 44625D & 44625E
CAPE CANAVERAL AS, FLORIDA

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature ($^\circ$ F)	Outlet Pressure (inches H_2O)	Power Usage (kw/hr)	Comments	Checked by (initials)

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